3.0 SURFACE WATER RESOURCES

Surface water resources discussed in Section 3 include hydrology, geomorphology, and water quality. Since channel geomorphology is closely linked to hydrologic conditions, hydrology and geomorphology are discussed together in Section 3.1. Section 3.2 examines surface water quality. Information regarding toxicology and human and ecological health concerns are discussed in Section 14, Human and Ecological Health Concerns and in Appendix J, Human Heath and Ecological Risk Assessment. Additional information pertaining to water supply and water diversions is addressed in Section 13, Public Services.

3.1 Hydrology and Geomorphology

3.1.1 Environmental Setting/Affected Environment

Lake Davis is located on Big Grizzly Creek, a tributary to the Middle Fork Feather River. The reservoir was constructed in 1967 by the California Department of Water Resources (DWR) as part of the State Water Project. The capacity of the reservoir is 84,371 acre-feet and covers a surface area of 4,026 acres with 32 miles of shoreline (DWR 1989). The mean depth of the reservoir is 20.5 feet with a maximum depth of 108 feet (DWR 1989). The surface elevation of the reservoir is approximately 5,770 feet with a spillway elevation of 5,775 feet at the dam.

Lake Davis is fed by five main tributaries: Big Grizzly Creek, Freeman Creek, Cow Creek, Jenkins Creek, and Dan Blough Creek. In addition, several smaller unnamed creeks are located along the western edge of the reservoir. The drainage area of Lake Davis is approximately 44 square miles of flat valley surrounded by mountainous terrain (DWR 1971). Lake Davis drains into Big Grizzly Creek and flows approximately 6.2 miles until joining the Middle Fork Feather River.

The vegetation surrounding Lake Davis is comprised of sagebrush with scattered pine on the flat low-lying areas near the reservoir. Dense stands of ponderosa pine and fir are located on the steeper slopes and ridges in the area. Wet stringer meadows surrounded by dense stands of lodgepole pine extend along the major tributary streams (USFS 1988).

3.1.1.1 Hydrology of Project Area and Vicinity

Average annual precipitation varies from 25 inches near the reservoir up to 40 inches on the surrounding peaks (DWR 1971). The majority of precipitation falls as snow during the winter months. As a result, larger flows from the tributaries also occur during the spring runoff months, specifically March and April.

Big Grizzly Creek Flow and Grizzly Valley Dam Flow Regime

Below Grizzly Valley Dam on Lake Davis, Big Grizzly Creek runs for 6.2 miles (10 km) to the Middle Fork Feather River, draining a watershed of 44-square-miles. The hydrology of Big Grizzly Creek below Lake Davis has two distinct periods, pre-dam flows (nonregulated flow) and post-dam flows (regulated flows). U.S. Geological Survey (USGS) gaging station (11391500), located at the Grizzly Valley Dam outlet, operated discontinuously from 1925 through 1980. There are 21 years with recorded daily average and instantaneous peak flows.

Once the dam was in place in 1966, DWR also monitored flows at the dam. The DWR period of record is from December 1966 through September 2004. The overlapping period of record for the USGS and DWR data were compared and found to be the same. Therefore, the USGS data, which were available in an electronic format, were used for describing hydrologic conditions and analysis (from 1925 to 1980), rather than the DWR data, which were available only in a hard-copy format. After 1980, the DWR flow records were used. Table 3.1-1 shows the period of recorded flows and the periods of missing data.

Table 3.1-1. Period of Flow Records for Big Grizzly Creek

10-1-1925 through 9-30-1931	Flow records from USGS
10-1-1932 through 9-30-1950	No flow records available from USGS
10-1-1950 through 9-30-1953	Flow records from USGS
10-1-1953 through 9-30-1954	No flow records available from USGS
10-1-1954 through 9-30-1967	Flow records from USGS
10-1-1967 through 9-30-1968	No flow records available
10-1-1968 through 9-30-1980	Flow records from USGS
12-1-1966 through 9-30-2004	Flow records from DWR, missing daily flows from months 6/1984, 9/1984, and 9/1978

There are 21 years of data available for the nonregulated flow period and 38 years of flow records for the regulated period. Figure 3-1 depicts the average daily flow for Big Grizzly Creek since 1925. Although 18 years of flow data are missing, higher average daily flows are noted for the nonregulated flow period. The mean of all average annual nonregulated flows for the period of record was 38 cubic feet per second (cfs), while the mean of all average annual regulated flows is 30 cfs (Table 3.1-2).

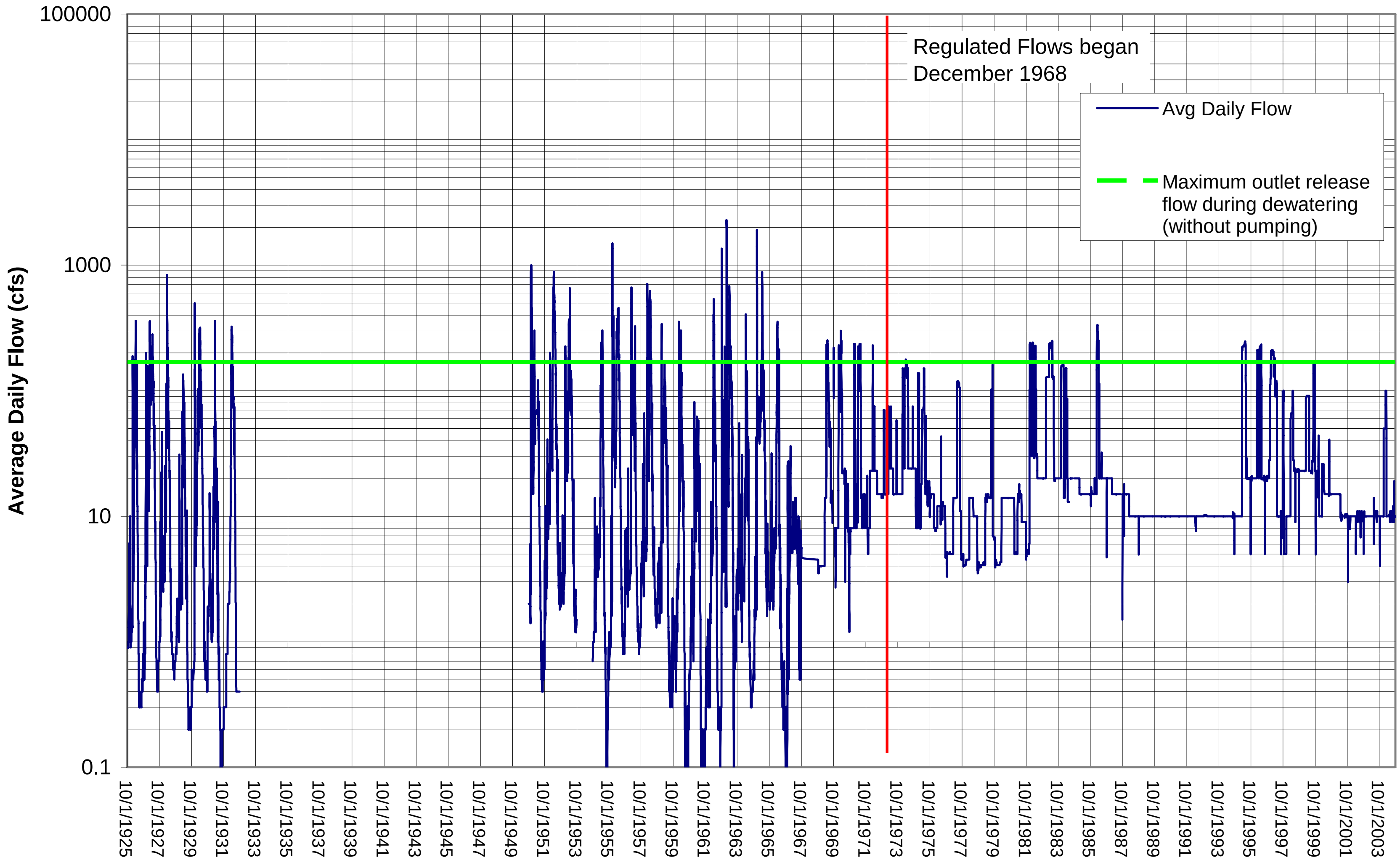

Figure 3-1 Average Daily Flow for Big Grizzly Creek from WY 1925–2004 USGS Gage 11391500 and DWR Records

Table 3.1-2. Big Grizzly Creek Average Annual Flows for Nonregulated and Regulated Periods

Nonregulated Flows		Regulated Flows	
Year	**Average flow (cfs)***	**Year**	**Average Flow (cfs)***
1926	23.2	1969	39
1927	51.1	1970	40.9
1928	28.7	1971	54.1
1929	14.7	1972	26.2
1930	37.8	1973	20.8
1931	7.16	1974	54.7
1951	30.3	1975	37.8
1952	97.9	1976	9.26
1955	33.2	1977	28.7
1956	64.7	1978	8.03
1957	31.8	1979	21.4
1958	60	1980	9.6
1959	18.8	1981	10.9
1960	22	1982	77.3
1961	7.9	1983	96.8
1962	38.5	1984	48.9
1963	52.2	1985	16.6
1964	36.2	1986	50.5
1965	57.6	1987	15.3
1966	21.1	1988	12.1
1967	5.7	1989	10.0
		1990	10.0
		1991	10.0
		1992	9.9
		1993	10.0
		1994	10.0
		1995	65.6
		1996	58.4
		1997	81.0
		1998	27.7
		1999	48.9
		2000	17.1
		2001	12.9
		2002	9.9
		2003	10.0
		2004	20.2
Mean of all Average Annual Flows	**38**		**30**

*Data acquired from average daily flows.

Average monthly flows for regulated and nonregulated periods are shown in Table 3.1-3. The average daily flows were used to compute the average monthly flows. Most runoff occurs during the months of March, April, and May, in both regulated and nonregulated periods, due to spring snowmelt. Average monthly flows during these spring runoff months have decreased since operation of the dam. The highest average monthly flows prior to regulation occurred in April (160 cfs). Since operation of the dam, the highest monthly flows occur in March and April (56 cfs). To help prevent Grizzly Valley Dam from spilling, releases of up to 235 cfs are made in the spring in some years (California Department of Fish and Game [DFG] 1997). During the summer and fall low-flow seasons (June to November), average monthly flows are greater under regulated conditions. Summer flow below the dam was generally between 10.6 and 21.2 cfs from 1974 to 2004 (Brown 2005). Based on inspection of the daily data, the very low- to no-flow periods during the summer and fall months are less frequent under regulated conditions. The minimum instream flow below the dam is 10 cfs year round.

Table 3.1-3. Average Monthly Flows for Big Grizzly Creek*

	Nonregulated Flows (cfs)	Regulated Flows (cfs)
Oct	5.4	13
Nov	9.7	14
Dec	35	21
Jan	23	37
Feb	45	32
Mar	74	56
Apr	160	56
May	88	48
June	17	23
July	2.1	18
Aug	0.9	19
Sep	0.9	15

*Average daily flows were used in the calculation of average monthly flows.

A flood frequency analysis was prepared from the instantaneous peak annual flow data for regulated and nonregulated periods. The results of the flood frequency analysis are presented as recurrence intervals in Table 3.1-4. During the nonregulated years, annual peak flows ranged from 89 to 4,080 cfs. Following operation of the dam, annual peak flows significantly decreased, ranging from 10 to 334 cfs. For alluvial channels, the 1.5-year recurrence interval (the annual peak flood that can be expected to recur about two out of every three years) is an approximation of the flow magnitude that maintains the channel form by transporting most of the sediment load over the long term (Andrews and Nankervis 1995). On Big Grizzly Creek, the 1.5-year flow is 480 cfs for the nonregulated period, and 16 cfs for the regulated period.

Table 3.1-4. Recurrence Intervals for Nonregulated and Regulated Flows

Recurrence Interval (years)	Nonregulated Flows (cfs)	Regulated Flows (cfs)
1.1	185	10
1.25	440	14
1.5	480	16
2	730	75
5	1,790	233
10	2,600	250
25	4,100	300

Since construction of Grizzly Valley Dam, large flow events have been infrequent and of relatively low magnitude compared with the nonregulated flow regime. Most uncontrolled spills at Lake Davis occurred during the first two decades of operation, but DWR has managed the reservoir in recent years so that spills rarely occur, in an effort to prevent the escape of pike downstream of the dam.

The average daily flows were used to develop flow duration curves (Figure 3-2). Flows between the 1 to 29 percent exceedance (20 cfs or greater) are higher under nonregulated conditions, while flows between the 30 to 100 percent exceedance (less than 20 cfs) are greater under the regulated hydrologic regime. A flow of 14 cfs is equaled or exceeded 50 percent of the time under the regulated flow regime. Prior to operation of the dam, 3.8 cfs was equaled or exceeded half the time. Table 3.1-5 shows the percentage of time that selected discharges from the flow duration curve are equaled or exceeded. All flows 20 cfs or less occur more frequently under the regulated hydrologic regime, while all flows greater than 20 cfs occur more frequently under the nonregulated regime (see Figure 3-2 and Table 3.1-5). Minimum streamflow releases from Grizzly Valley Dam have enhanced the season low flows in Big Grizzly Creek, and the storage capacity provided by the dam has attenuated seasonal peak flows.

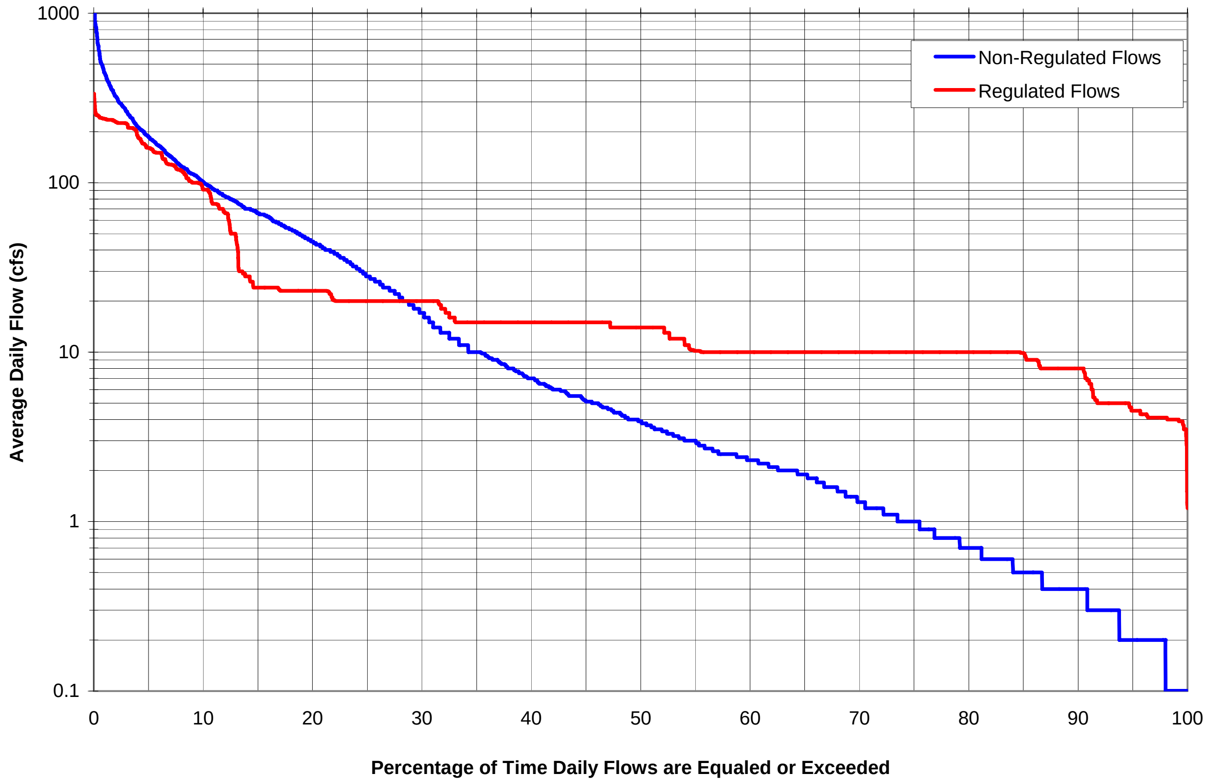

Figure 3-2 Flow Duration Curves for Big Grizzly Creek

Table 3.1-5. Average Daily Flow Exceedance for Nonregulated and Regulated Flows

Percentage of Time Flows Equaled or Exceeded	Nonregulated Flows (cfs)	Regulated Flows (cfs)
1	442	238
5	187	160
10	90	100
15	66	24
20	45	23
25	28	20
30	17	20
50	3.8	14
90	0.4	8

Middle Fork Feather River Flow Regime

The Middle Fork Feather River is nearly 108 miles long and drains a 1,240 square mile watershed composed of three geomorphically distinct areas; the eastern Sierra Valley, the central glacial valleys, and the Middle Fork Canyon (DFG 1982). The headwaters of the river are located near the town of Vinton in Plumas County and it flows into Lake Oroville in Butte County. Notable tributaries along this river include: Big Grizzly Creek, Sulphur Creek, Frazier Creek (drains from Gold Lake), Nelson Creek, Onion Valley Creek, Bear Creek, Willow Creek, the Little North Fork of the Middle Fork Feather River, South Branch of the Middle Fork Feather River, Fall River, and Frey Creek.

The Sierra Valley section of the Middle Fork Feather River extends from Vinton to Clio. Numerous creeks and an interconnected irrigation system join near Vinton to form the headwaters of the Middle Fork Feather River. The valley is a flat-bottomed lake bed at an elevation of 4,880 feet (DFG 1982). In this reach, habitat is characterized by long shallow pools with few interspersed riffles. Summer flows drop to very low levels (<0.2 cfs) in many of the upper tributaries. However, Little Last Chance and Big Grizzly creeks flowing from Frenchman Lake and Lake Davis, respectively, usually provide flow year round due to releases of stored water. The minimum required release is 2 cfs (or reservoir inflow, whichever is less) from Frenchman Lake with Lake Davis providing an additional 10 cfs or more.

The central valleys are a series of narrow, inter-connected glacial valleys, ranging from 0.5 to 2 miles across their floors (DFG 1982). This section has a low gradient. From Portola to Sloat, the river drops only 700 feet in 31 miles. The average low flow in this area is about 16 to 40 cfs, occurring in October.

The Middle Fork Canyon extends from about 1 mile below Sloat to Lake Oroville. This 48 mile reach is steep and rugged, dropping at a rate of 67 feet per mile. The average low flow in this portion of the river is about 70 to 140 cfs. This reach is characterized as “rugged, remote and pristine” (DFG 1982).

Big Grizzly Creek drains into the Middle Fork Feather River approximately 6.2 miles below Grizzly Valley Dam. A USGS gaging station (11392100) on the Middle Fork Feather River is located approximately one mile downstream of the confluence. The gaging station is near the town of Portola, and encompasses a drainage area of 586 square miles. The USGS gage has 12 years of continuous flow data from October 1, 1968, through September 30, 1980. Flows on the Middle Fork Feather River are influenced by regulation from Lake Davis and Frenchman Lake.

The Middle Fork Feather River has a similar seasonal flow pattern to Big Grizzly Creek. High-flows primarily occur in the winter and spring, January through May, with pronounced low-flow periods during the summer. The mean of the average annual flows is 245 cfs, with annual averages ranging from 71 to 490 cfs (nine years of complete data available). Daily average flows range from 3 to 6,850 cfs (Figure 3-3).

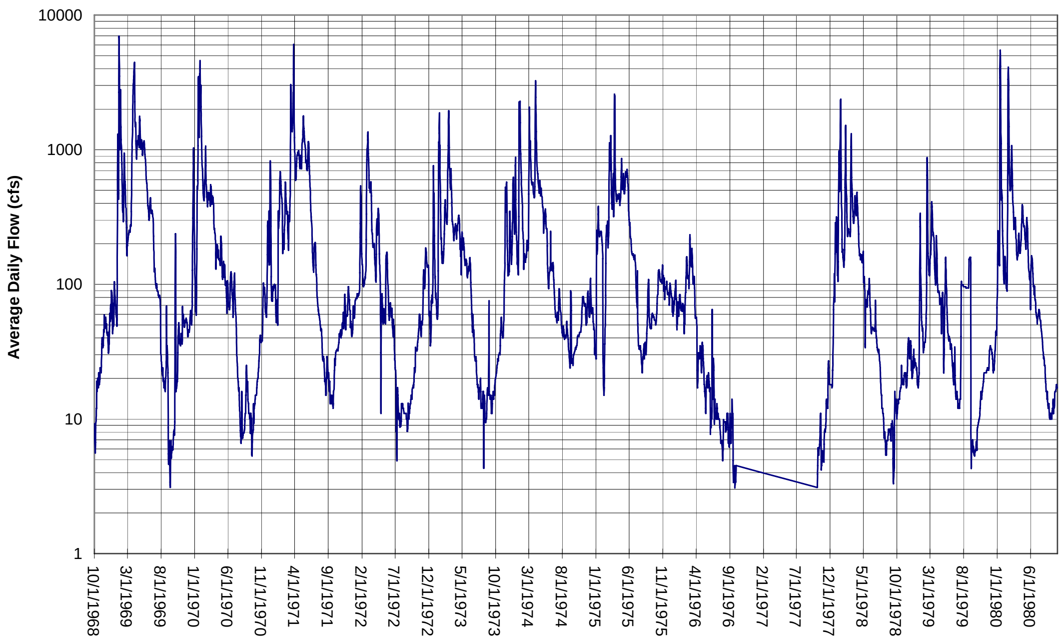

Figure 3-3 Middle Fork Feather River near Portola, CA (USGS Gage 11392100 for WY 1968–1980)

Figure 3-4 is the flow duration curve for the Middle Fork Feather River. Table 3.1-6 shows the percentage of time that selected discharges from the flow exceedance curve are equaled or exceeded. The 50 percent exceedance is 72 cfs.

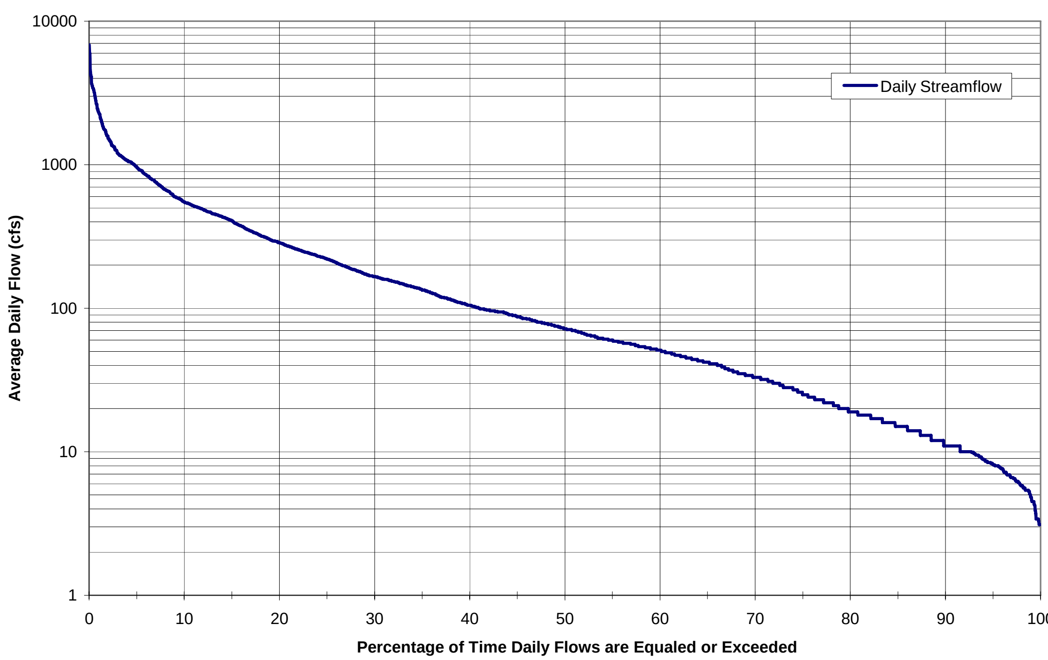

Figure 3-4 Daily Flow Duration for Middle Fork Feather River near Portola, CA (USGS Gage 11392100)

Table 3.1-6. Average Daily Flow Exceedance for Middle Fork Feather River

Percentage of Time Flows Equaled or Exceeded	Average Daily Flow (cfs)
1	2,340
10	548
20	287
25	220
30	166
50	72
90	11

There are 11 years of annual peak flow records for the Middle Fork Feather River, provided in Table 3.1-7. The highest peak flow recorded is 7,640 cfs and the lowest flow is 247 cfs.

Table 3.1-7. Annual Peak Flows Middle Fork Feather River

Water Year	Instantaneous Peak Flows (cfs)
1969	7,640
1970	4,970
1971	6,580
1972	1,570
1973	2,660
1974	3,650
1975	3,120
1976	247
1978	3,110
1979	1,140
1980	5,690

Lake Davis Storage and Water Surface Elevation Levels

Lake Davis water surface elevation depends upon the incoming stream flow from the tributaries and the loss of water due to downstream releases and from evaporation and seepage. Since December 1966, DWR has controlled the amount and duration of flows released from the reservoir. Releases to Big Grizzly Creek downstream are dictated by an agreement between the DWR, DFG, and USFS, consistent with the DWR’s two Water Rights Permits for storage and use of Big Grizzly Creek water (permits 15254 and 15255). Under this agreement, minimum streamflow releases are determined annually based on Lake Davis storage on May 1 or anticipated storage during the May-June period. Minimum streamflow releases include flow for fishery enhancement, recreation, and downstream diverters on Big Grizzly Creek with water supply agreements with DWR (see Sections 2, Project Alternatives, and 13, Public Services, for information on diversions and a detailed description of water supply uses). Lake Davis began storing water in December of 1966 and took approximately seven months to become useable. Figure 3-5 shows the monthly water surface elevation of Lake Davis for its entire history from December 1966 through December 2004.

Figure 3-6 shows the minimum and maximum storage in each water year since October 1970. The lowest volume of water stored in the lake occurred in November 1992 with 28,148 acre-feet of water in the second year of a critical drought. The largest amount of water stored in Lake Davis was 85,580 acre-feet in March 1973 when uncontrolled spills occurred. The largest range in reservoir storage over one water year occurred in 1992–1993. In November 1992, the reservoir volume reached 28,148 acre-feet following several years of drought. Then large rain storms in the spring brought the lake up to 68,908 acre-feet in June 1993, an increase of 40,760 acre-feet. The average storage volume for the entire period of record is 62,874 acre-feet with a median storage of 64,613 acre-feet. Since DWR began to operate Grizzly Valley Dam in 1999 to reduce the chances of spill in order to help manage pike, the average (mean) storage volume has been 56,300 acre-feet with a median storage of 55,300 acre-feet.

Lake Davis Boat Ramps

There are four concrete boat ramps at Lake Davis that provide access for larger boats. The four ramps and their highest and lowest elevation points are:

	Highest Elevation	Lowest Elevation
Honker Cove	5,777.1	5,762
Mallard	5,779	5,770
Camp 5	5,776.5	5,760.8
Lightning Tree	5,778.8	5,765

Reservoir elevations have fluctuated up to two feet above and below a mean elevation of 5,764 feet in the previous four years. While the boat ramps at Mallard and Lightning Tree have been dry during this period, Honker Cove and Camp 5 have remained in use. All of the boat ramps were completely out of service during the drought in 1991–1992, when the reservoir elevation dropped to its lowest historical elevation of 5,757 feet. The ramps are in good condition (Ivan Paulsen, personal communication, 2006).

3.1.1.2 Geomorphology of Project Area and Vicinity

Five named tributaries and numerous smaller springs and creeks are the primary sources of water to Lake Davis and Big Grizzly Creek downstream of the dam. All of the named creeks and most of the smaller tributaries and springs are located along the western edge of the reservoir. Historically, the tributaries and springs flowed into the main branch of Big Grizzly Creek at what is presently Lake Davis.

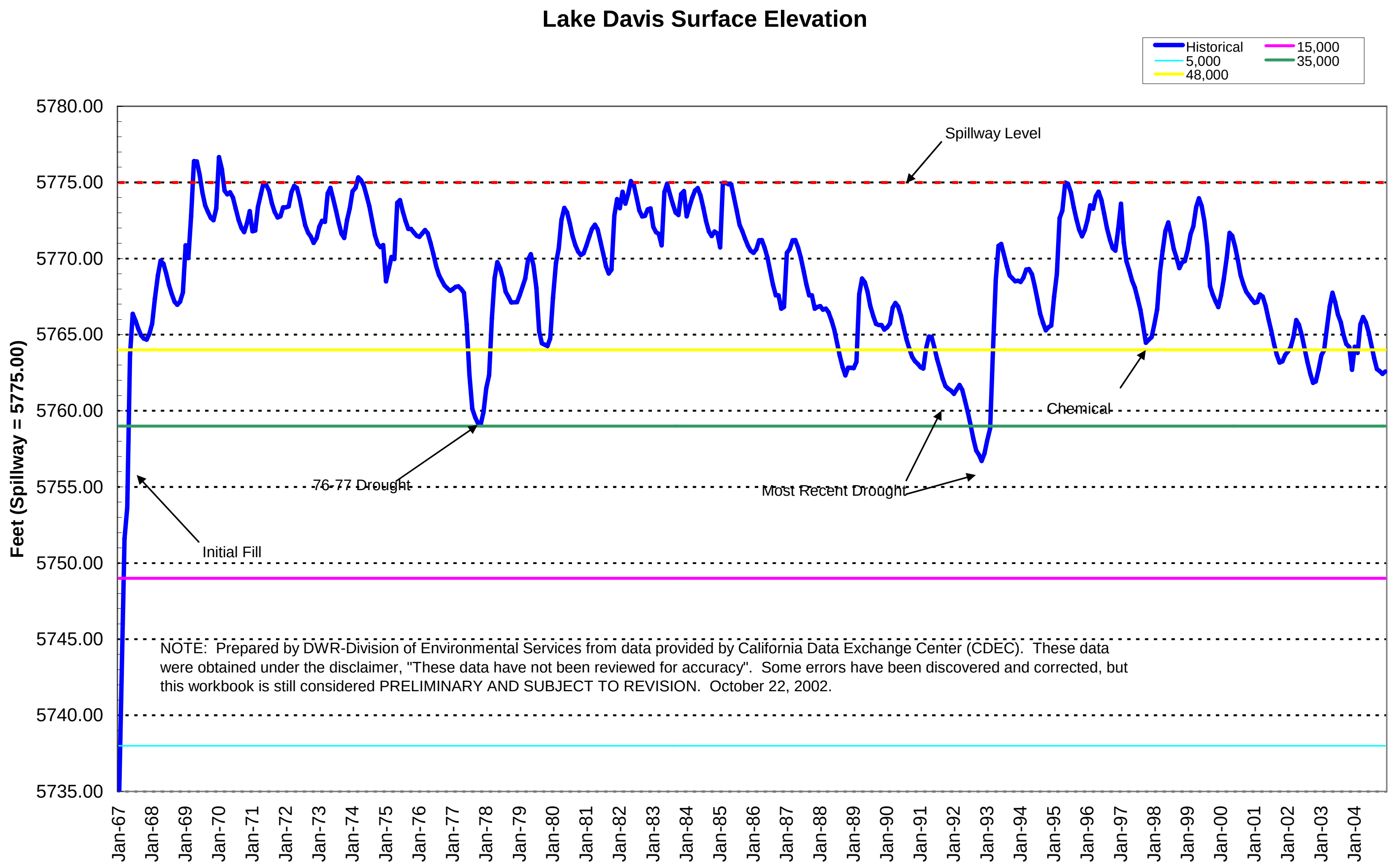

Figure 3-5 Lake Davis Water Surface Elevation

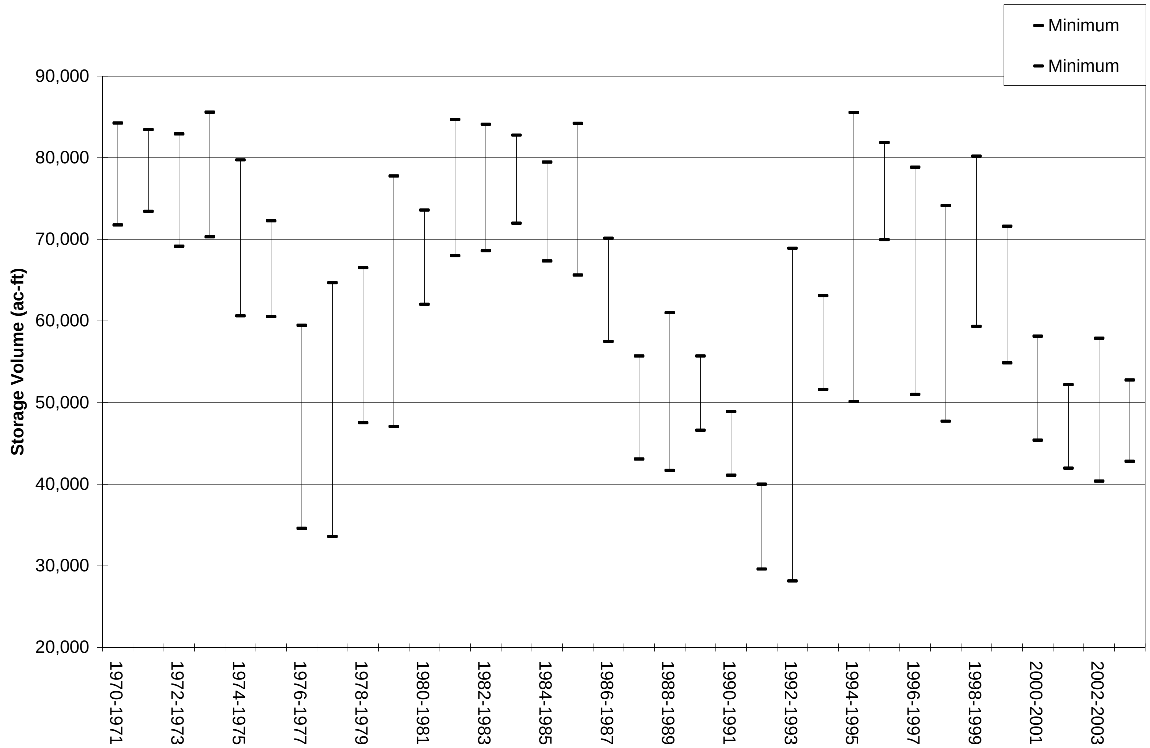

Figure 3-6 Minimum and Maximum Lake Davis Storage Volumes by Water Years 1970–2004

Big Grizzly Creek

Big Grizzly Creek is the largest of the tributaries to Lake Davis. It is a third order stream draining a watershed of about 44 square miles (11,396 hectares). It begins as the overflow of Summit Lake and runs through about 5.5 miles (8.9 km) of open meadow before emptying into Lake Davis. Big Grizzly Creek has 13 tributaries, four of which are second order streams and one is a third order stream. The total length of tributary streams including the main-stem is estimated to be about 32 miles (51.5 km). It is unknown how much of this channel length is perennial or how much of it may go dry or have residual pools of water during the summer. The mainstem of Big Grizzly Creek is reported to be perennial (USFS 2004a), as is Old House Creek, its largest tributary. However, Old House Creek has been reported to go dry around mid July (Schatz no date, Newman no date). Old House Creek joins Big Grizzly Creek about 1.5 miles (2.4 km) upstream of Lake Davis.

Big Grizzly Creek begins in the hills along the northwestern slope of the reservoir at elevation 6,320 feet. The gradient from the headwaters to Grizzly Valley is approximately nine percent. The creek flows in a northern direction towards Summit Marsh located in Grizzly Valley, at elevation 5,840 feet. At Grizzly Valley, the steep stream gradient flattens to less than 0.3 percent. The creek flows east for over 1.5 miles through this wide valley towards the reservoir. The channel sinuosity slightly increases through Grizzly Valley, and dramatically increases as it approaches elevation 5,775 feet and Lake Davis. Based on aerial photography and site inspection, the channel is poorly to moderately entrenched. At various locations, the channel splits into two or three branches. Numerous smaller tributaries, several of which appear to be spring-fed, also drain into Big Grizzly Creek at various locations. The creek drains into Lake Davis near 5,775 feet elevation. The USFS has identified numerous channel bed incisions or “head-cuts” during field inspections on many of the tributaries draining to Lake Davis. Most of the head-cuts range from 1.5 to 4 feet in depth. The USFS did not survey Big Grizzly Creek itself for head-cuts, although the channel is known to be in poor condition due to downcutting, gullies, and unstable banks (Barbara Drake, USFS, personal communication, 2006). The most downstream head-cut is located approximately 0.5 mile upstream from the reservoir.

It is unknown what the initiating causes of the head-cuts are, but they may be related to land use activities such as grazing, fluctuations of the reservoir level, or potentially both (Barbara Drake, USFS, personal communication). Water surface elevations in Lake Davis have historically fluctuated over an 18-foot range. Fluctuation in the water surface elevation of the reservoir can cause adjustments in the channel, including channel bed incision (head-cutting). Excessive channel bed incision can cause over-steepening of streambanks that leads to undercutting, collapse and erosion. During the past 10 years, the USFS has implemented various bank erosion control treatments on the tributary streams (Barbara Drake, USFS, personal communication, 2006). All of the tributary streams draining to Lake Davis are potentially subject to vertical instability due to head-cutting.

Downstream from Lake Davis, Big Grizzly Creek is a steep, moderately entrenched channel, with a moderate sinuosity for approximately 2.6 miles. The gradient is approximately 5 percent. From 2.6 miles downstream of the reservoir to approximately 4.4 miles below Grizzly Valley Dam, the valley begins to widen at at Grizzly Ice Pond and the average gradient is 3 to 4 percent. Grizzly Ice Pond is a small lake formed by a dam at Walton’s Grizzly Lodge located 4.4 miles below Grizzly Valley Dam. Below Grizzly Ice Pond, the valley continues to widen, and the channel becomes less entrenched, with localized gradients flattening to one percent. The channel splits at several locations below Grizzly Ice Pond. Big Grizzly Creek joins the Middle Fork Feather River at elevation 4,865 feet.

Overall, the stream banks and canyon walls downstream from Lake Davis are densely vegetated with grasses and willows which provide channel stability. The channel bed appears to be dominated by cobbles, with gravels and fines (sand size or smaller) also present, and at some locations bedrock is exposed. Flows of approximately 120 cfs, observed on June 6, 2006, were near bankfull elevations based on present-day geomorphic indicators. There is little erosion due to the densely vegetated and stable channel banks.

Freeman Creek

Freeman Creek is located south of Big Grizzly Creek and begins near the top of Threemile Valley and Willow Creek Road at elevation 6,540 feet. Freeman Creek is also a third order stream. The mainstem of Freeman Creek is about 4.5 miles long. The watershed area is about 6 square miles (1,553 hectares) drained by about 12 miles (19.6 km) of mainstem and tributary channels. Freeman Creek has seven tributaries, one of which is a second order stream, the remaining six are first order streams. Three springs have been identified within the Freeman Creek watershed from USGS topographic maps. Springs discharge to Freeman Creek in Threemile Valley as well as in areas closer to the confluence with Lake Davis. The mainstem of Freeman Creek is reported to be perennial (USFS 2004a). It is unknown how many of the tributary streams and springs are perennial. Flows in Freeman Creek during the spring of 1983 and 1984 were reported as ranging from 5.5 to 7.1 cfs (Schatz, USFS, no date) and a flow of 5 cfs was estimated in October 1973 (USFS 1973 stream survey notes, unpublished).

Freeman Creek follows a similar topographic drainage pattern as Big Grizzly Creek and also drains into the reservoir at an elevation of 5,775 feet. Freeman Creek appears to be slightly less sinuous than Big Grizzly Creek and is confined to a single channel. The gradient of the upper reach is four percent, but flattens out in Grizzly Valley to less than one percent. Head-cuts existed on Freeman Creek, but as of 2004, the USFS has repaired them all (Barbara Drake, USFS, personal communication, 2006). There is one head-cut on a tributary of Freeman Creek.

Cow Creek

Cow Creek is located south of Freeman Creek and begins at the base of Smith Peak, elevation 7,080 feet. Cow Creek is the smallest of the three main tributaries to Lake Davis. It is a second order stream with only one tributary. No springs are noted on USGS topographic maps within the Cow Creek watershed. The stream is reported to be perennial (USFS 2004a). Summer flows average 0.05–0.75 cfs and high spring flows range from two to five cfs (Schatz, USFS, no date). Cow Creek drains a watershed of about 4.7 square miles (1,217 hectares) with about 5.7 miles (9.2 km) of stream channel.

The channel gradient is 11 percent in the upper reach. Cow Creek also has a similar topographic drainage to Freeman and Big Grizzly creeks. Within the wide flat valley close to the reservoir (one percent gradient), aerial photography showed several smaller wetland or marshy areas where water appears to pond. This suggests localized areas of high groundwater table and low channel gradients. The creek is mostly straight as it flows into the reservoir at an elevation of 5,775 feet. Two head-cuts were identified by the USFS on Cow Creek, both very close to the confluence with Lake Davis.

Jenkins Creek

Jenkins Creek is a first order spring-fed stream that is believed to be intermittent (USFS 2004a). It is the shortest of all the named creeks and only flows for approximately 0.5 mile before draining into Lake Davis. Jenkins Creek flows with little sinuosity down a steep drainage (approximately three percent gradient) flowing directly east into the reservoir. Springs provide ephemeral flow for most of the year except during the dry summer months. The creek enters the reservoir at an average elevation of 5,775 feet. Four head-cuts were identified by the USFS on Jenkins Creek, all of which are within 0.3 mile of the reservoir.

Dan Blough Creek

Dan Blough Creek is the southernmost of the named creeks and originates at elevation 6,780 feet. Dan Blough Creek is a second order perennial stream (USFS 2004a) which drains into Dan Blough Cove on the southwestern edge of Lake Davis. The total length of stream channel (mainstem and tributaries) is estimated to be about 4.6 miles (7.4 km) about 1.5

miles of this length lie below known springs. The creek drains east, down the steeper gradient valley slopes (approximately 19 percent gradient) picking up several smaller tributaries before flowing northeast along the valley floor. The gradient flattens to approximately three percent as it drains into the reservoir at an elevation of 5,775 feet. Dan Blough Creek appears to have some localized reaches of high sinuosity, but overall, the sinuosity is low. Dan Blough Creek was not inspected by the USFS for head-cuts.

Other Tributaries and Springs

Seventeen other small, unnamed creeks are shown as "blue-line" streams on USGS topographic maps, flowing into Lake Davis. These are generally small, first order unnamed streams less than one mile in length. Four of these 17 streams contain springs within their watersheds based on USGS topographic maps. Only one of these streams, located on the northeastern side of the reservoir, is second order. These 17 tributaries collectively represent 17.6 channel miles (28.3 km)

3.1.1.3 Regulatory Environment

The DWR operates Lake Davis in conformance with the provisions contained in Water Rights Permits 15254 and 15255 (Applications 16950 and 21443) issued by the California State Water Resources Control Board (CSWRCB). Those permits specify that minimum streamflow releases must be at rates set forth in the agreement between the DWR and DFG. Stream flows in Big Grizzly Creek are established by Memorandum of Agreement (MOA) between the DWR, DFG, and U.S. Forest Service (USFS). The MOA stipulates that minimum releases are to be determined annually on May 1, and are dependent upon actual or anticipated volume of Lake Davis during the May through June period. Minimum release to Big Grizzly Creek is normally 10 cfs (CSWRCB 1994).

There are four known recorded diversions and perhaps several unrecorded riparian diversions from Big Grizzly Creek. These diversions include an impoundment at Walton's Grizzly Lodge (Grizzly Ice Pond), Ramelli and Valberde Diversion Agreements governed by water rights agreements with the DWR, and the proposed diversion for the Grizzly Ranch Development Project scheduled to be constructed during the summer of 2006. In addition, there are several riparian diversions. A detailed description of the diversions and water use, including drinking water supply is in Section 13.1.4, Downstream Water Use.

The Sierra Nevada Framework Plan Amendment (SNFPA) sets forth various goals, objectives, and guidelines for managing aquatic, riparian, and meadow ecosystems and their associated species. Of particular relevance to the environmental concerns addressed and evaluated in this section (see Section 3.1.2.1), are several of the objectives listed under Riparian Conservation Objective #2, which provides for the following (USFS 2004a):

- **Floodplains and Water Tables:** Maintain and restore the connections of floodplains, channels, and water tables to distribute flood flows and sustain diverse habitats;
- **Stream Banks and Shorelines:** Maintain and restore the physical structure and condition of stream banks and shorelines to minimize erosion and sustain desired habitat diversity; and

- **Streamflow Patterns and Sediment Regimes:** Maintain and restore in-stream flows sufficient to sustain desired conditions of riparian, aquatic, wetland, and meadow habitats and keep sediment regimes as close to possible as those in which aquatic and riparian habitat biota evolved.

Consistency with Riparian Conservation Objectives (RCOs) is a requirement under the SNFPA Supplemental EIS (SEIS) Record of Decision (ROD). Specifically, the ROD states that new proposed management activities (such as the Lake Davis Pike Eradication Project) within Critical Aquatic Refuges (CARs) and Riparian Conservation Areas (RCAs) need to be evaluated during environmental analysis to determine consistency with the RCOs at the project level and the AMS goals for the landscape. The ROD also specifies that appropriate mitigation measures are enacted to (1) minimize the risk of activity-related sediment entering aquatic systems and (2) minimize impacts to habitat for aquatic- or riparian-dependent plant and animal species. Since the project area includes several RCAs, an analysis of project consistency with meeting RCOs has been conducted and is found in Section 7.2.1.4, Special Status Species of Terrestrial Wildlife.

3.1.2 Environmental Impacts and Consequences

3.1.2.1 Evaluation Criteria and Environmental Concerns

Three potential environmental concerns are identified and evaluated:

- bank erosion on Big Grizzly Creek downstream from Grizzly Valley Dam;
- tributary incision (head-cutting) on all streams draining to Lake Davis; and
- structural instability of boat ramps.

The physical processes that raise these environmental concerns as a result of the Proposed Project and project alternatives are described below.

Bank Erosion

An increase in the magnitude and duration of flows along Big Grizzly Creek may cause bank erosion. Sustained high flows released from the dam during drawdown of the reservoir may increase the potential for channel bank scour, scour of riparian vegetation, and saturation of streambanks, which together can cause bank failure and erosion. In order for bank erosion to occur, flow magnitude must be high enough to fill the channel to some height above the low-flow channel so that the water surface elevation reaches the elevation of the streambanks, and it must also exert sufficient shear stress to mobilize bank material. If the flow magnitude does not exert sufficient shear stress to mobilize bank material, then erosion will not occur. Long-duration flows can saturate stream banks so that they are more susceptible to failure with lower magnitude flows (and lower shear stress) than higher magnitude flows of much shorter duration. Therefore, the magnitude and duration of flow releases from Grizzly Valley Dam during the drawdown or dewatering process must be considered.

Tributary Incision

Tributary incision is possible whenever the water surface elevation is below the channel bed elevation of the tributaries flowing into Lake Davis. The inflowing tributaries can potentially downcut through the reservoir deposits to meet the new, lower lake level during the drawdown and refill periods. If flows in the tributaries during the seasonal runoff period are of a magnitude capable of mobilizing bed material, then incision can potentially take place as the channel adjusts to a lower base level that is defined by the lowered reservoir elevation. The channel will seek to readjust its gradient to a stable longitudinal profile that is controlled by the elevation of the reservoir. Incision would most likely start near the lowered reservoir elevation and can work its way upstream. Once initiated, channel incision can continue to progress headward (i.e., head-cutting) until an equilibrium gradient is achieved, even if the reservoir base level returns to pre-project elevations. Down-cutting can cause a disconnection with the surrounding floodplain, reducing the frequency of overbank flows, causing drying of meadows and wetlands, and can over-steepen stream banks causing bank failure and erosion.

Structural Stability of Boat Ramps

Under some of the project alternatives, lowering of the water level would expose all of the concrete boat ramps in place around the reservoir. Hydrostatic pressure would be created between the concrete ramps and the saturated lake sediments below the ramp if the reservoir were drawn down faster than it takes the sediments to drain. A possible consequence of too-quick-a-drawdown is that dewatering can cause the ramps to heave, and possibly crack or break apart.

Evaluation Criteria

Bank erosion and tributary head-cutting (incision) can cause substantial soil erosion, a loss of channel bed and bank stability, disconnection from the floodplain, and lowering of the water table. These changes are considered to be significant impacts. The following Section 3.1.2.2 provides specific, quantitative information for determining when bank erosion and tributary head-cutting reach a level that is considered to be significant.

Any substantial physical deterioration of recreational facilities that would require repairs in order to be operative is considered a significant impact. Thus, changes in the boat ramp facilities, such as buckling and cracking due to project/action alternatives, would be considered a significant impact.

The significance criteria are summarized below:

- The criteria for bank erosion on Big Grizzly Creek downstream from the dam are:
  - Flow releases <240 cfs; no significant impact, regardless of flow duration;
  - Flow releases >240 cfs with <70 days duration; no significant impact;
  - Flow releases >240 cfs and lasting >70 days; significant impact.
- The criterion for tributary incision is:

- Lake Davis elevation below 45,000 acre-feet (5,763.5 feet elevation) for more than two runoff seasons (March, April, May) represents a significant impact.

- The criterion for structural stability of boat ramps is:
  - Drawdown rates that are faster than one foot per day over any part of the existing boat ramps are deemed to be a significant impact.

3.1.2.2 Evaluation Methods and Assumptions

Historical flow data and hydrologic models, developed by the DFG, were used to evaluate the potential impacts of the Proposed Project alternatives on the environmental concerns identified above. The models were used to quantify outflows below Grizzly Valley Dam during the drawdown/dewatering process, and the length of time the reservoir would be drawn down before refilling occurs (see Appendix D). A more detailed description of how DFG models were used is described under each of the relevant issues below.

Bank Erosion on Big Grizzly Creek Downstream From the Dam

As stated under Section 3.1.1.1, approximately the 1.5-year recurrence interval flow is accepted by geomorphologists as the channel-forming discharge for alluvial streams (Andrews and Nankervis 1995). The 1.5-year discharge is often referred to as the bankfull or effective discharge. Although regulated flows have been occurring on Big Grizzly Creek for the last 37 years, the channel was formed by centuries of the nonregulated flow regime. Flows much less than the channel forming discharge do not have the capacity to transport the sediment load, and have little geomorphic significance (although they may be significant to aquatic habitat conditions). There is no well-defined relationship in the geomorphic literature between the channel forming discharge and the potential for bank erosion. However, it is reasonable to assume that flows much less than the 1.5-year recurrence interval flow would not be likely to initiate bank erosion.

The 1.5-year nonregulated recurrence interval, or bankfull flow, on Big Grizzly Creek is 480 cfs (see Section 3.1.1.1). For purposes of this analysis, it is assumed that 240 cfs (50 percent of the 1.5-year flow) is the threshold of significance for defining the discharge at which bank erosion may be initiated. This is a smaller magnitude flow than the 1.5-year discharge of 480 cfs, which acknowledges that the bankfull flow used in the analysis is an approximation of the 1.5-year recurrence interval, but can be slightly more or less for a specific stream. It also is a very “conservative” estimate of the discharge magnitude that is likely to initiate bank erosion. Thus, for this analysis, project alternative flows that are less than 240 cfs would not cause significant bank erosion, regardless of the flow duration. Flows that exceed 240 cfs may cause bank erosion, depending upon the duration of those flows. Longer duration flows that exceed 240 cfs are more likely to saturate streambanks, and cause bank erosion. Table 3.1-8 shows the number of days sustained flows greater than 200 cfs occurred for nonregulated and regulated periods.

Table 3.1-8. Number of Events in which 200 cfs or Larger was Recorded for the Given Length of Time

Duration Period	Nonregulated Flow Events	Regulated Flow Events
0-5 days	5	11
6-10 days	9	0
11-15 days	4	2
16-20 days	3	3
21-40 days	2	5
41-70 days	2	3
Total Number of Events	**25**	**24**

Larger flow events (consecutive days of flow greater than 200 cfs) lasting up to 70 days have occurred on five occasions on Big Grizzly Creek. Based on these data, it is assumed that flows exceeding 240 cfs and lasting for more than 70 days can cause accelerated bank erosion (e.g., greater than natural nonregulated or regulated rates of erosion), and, therefore, represent a significant impact. Flows exceeding 240 cfs but lasting for less than 70 days are not assumed to cause accelerated bank erosion and therefore are not considered a significant impact. Visual inspection of the channel in June 2006 following several months of higher than normal sustained flows (100-200 cfs) did not indicate any substantial bank erosion or scour locations. Dense vegetation along the channel banks provide stability and decreases the potential for bank erosion. It is assumed that long duration flows larger than 240 cfs are required to generate sufficient shear stress to cause significant bank erosion by scouring and removing riparian vegetation. In summary, the criteria for bank erosion are as follows:

- Flow releases <240 cfs; no significant impact, regardless of flow duration;
- Flow releases >240 cfs with <70 days duration; no significant impact; or
- Flow releases >240 cfs and lasting >70 days; significant impact.

The goals and objectives of the SNFPA are consistent with the criteria outlined for floodplain connections, bank erosion, and sediment transport on Big Grizzly Creek. If flows released downstream remain below the criteria for bank erosion, then the SNFPA policies are considered consistent with the project alternatives.

The DFG drawdown model was used to determine flows below Grizzly Valley Dam. For this analysis, two starting reservoir elevations for January were used: 45,000 acre-feet and 60,000 acre-feet. The 60,000 acre-foot elevation is approximately the long-term historic-average-January elevation of the reservoir. The 45,000 acre-foot-starting elevation corresponds to approximately the elevation at which DWR is operating the reservoir to manage for pike in recent years (i.e., No Project, and see Figure 3-5). Depending upon the starting drawdown elevation, it can take a longer or shorter period of time to reach any given drawdown target. Also, the higher the lake level, the greater the discharge at the outlet due to hydraulic head. For modeling purposes, the single-flow gate at the 5,700-foot elevation at Grizzly Valley Dam is assumed to be releasing the maximum discharge (145 cfs) feasible through the range of reservoir elevations until the drawdown target is met. Flows as high as 200 cfs are possible if the discharge from the reservoir is bypassed around the fish screen through the grated bypass pipe. The maximum discharge of 145 cfs was used to estimate the flows out of the dam and it was assumed that flows were not bypassed.[1]

Auxiliary pumping is also possible, adding an additional 50-100 cfs of flow downstream, and it was used in the modeling for a defined period of time whenever the drawdown target was not met by October. Using the DFG drawdown model, it was determined that pumping would be required in wet years and average years starting at 60,000 acre-feet of water storage (historical condition), for the 5,000 acre-feet and completely dewater alternatives (see description of wet, average, and dry years below). The anticipated periods of time when pumping would be required in wet years and average years starting at 60,000 and 45,000 acre-feet under each of the project alternatives and the range of pumping rates, are as follows:

Project Alternatives	Drawdown from 60,000 Acre-Feet	Drawdown from 45,000 Acre-Feet
48,000	Wet Year: January-September (50 cfs)	None
35,000	Wet Year: January–September (50 cfs)	Wet Year: June-September (50 cfs)
15,000	Wet Year: January–September (75 cfs)	Wet Year: January–September (50-100 cfs)
5,000	Average Year: June-September (50 cfs) Wet Year: January–September (75–100 cfs)	January–September (75–100 cfs)
Dewater	Average Year: June-September (50 cfs) Wet Year: January–September (100 cfs)	January–September (75–100 cfs)

Model simulations for three different types of water years ("average," "wet," and "dry") were used to predict the range of flows discharged into Big Grizzly Creek for each of the project alternatives. Representative average, wet and dry year types were selected based upon review of the range of annual inflows to the reservoir, as derived from the DFG model. The average inflow calculated from all modeled years in the period of record was 34,000 acre-feet, which is most closely represented by 1973 (30,955 acre-feet). Therefore, 1973 was selected to represent the average water year. The maximum inflow to the reservoir was approximately 84,000 acre-feet, so 1983 (84,044 acre-feet) was used as the representative wet year type. The most recent minimum inflow to the reservoir was 7,286 acre-feet in 2001, which is used in this analysis to represent a dry year. The duration and magnitude of flows released downstream were estimated based on the model simulations for these three water year types.

Tributary Incision

Since 1997, DWR has been managing the reservoir to prevent spills. The average reservoir elevation since 1997 is 56,000 acre-feet (5,767 feet elevation) when the DWR began to

[1]Outflow may be constrained during some periods by the needs of downstream water users. Although these constraints have not been incorporated into the model output, they are addressed as mitigations in the affected resource sections such as recreation and public services (water rights).

operate the reservoir to reduce spills in order to control pike escapement. The median minimum reservoir elevation since 1997 is approximately 45,000 acre-feet (5,763.5 feet elevation). It is assumed that tributary channel bed elevations are probably fluctuating in response to monthly and annual changes in reservoir elevation between 5,763.5 and 5,775 feet (full-pool).

For purposes of this analysis, it is assumed that any reservoir elevation below 45,000 acre-feet (5,763.5 feet elevation) is the threshold for causing excessive channel incision and head-cutting and is considered significant. Once head-cutting is initiated, the head-cut can be self-sustaining and continue to progress upstream until it either reaches a hard-point (such as, a bedrock outcrop or boulders) and can no longer move upstream, or the reservoir rises back up to an elevation that drowns the incision.

Progressive upstream head-cutting is not likely to advance without instream flows of sufficient magnitude to cause bed incision. The flow magnitude must be large enough to generate the shear stress that allows the channel to adjust its gradient and elevation to a new, lower reservoir elevation. Most runoff to Lake Davis occurs during the months of March, April, and May (see Section 3.1.1), although peak runoff can occur during other winter months. It is very unlikely that after May, during the summer and fall months, there would be enough precipitation and runoff to cause tributary bed elevations to adjust. Therefore, whenever the reservoir level is lowered below 45,000 acre-feet of storage during the months of March, April, or May, there is a relatively higher risk of incision. Additionally, the greater the number of years when the reservoir is drawn down below 45,000 acre-feet during these critical runoff months, the greater the risk of channel bed incision migrating upstream.

For purposes of this analysis, reservoir levels below 45,000 acre-feet storage (5,763.5 feet elevation) during March, April, or May can initiate substantial head-cutting. It is assumed that it would require at least two runoff seasons below the 45,000 acre-feet storage level before any head-cut could travel far enough upstream to a point where it can cause significant impacts. Channel incision that occurs at the lowest reservoir elevations and that has not traveled far upstream would be drowned upon refill, so that the head-cut can no longer progress upstream, unless it is re-exposed at some future time. A head-cut that travels upstream beyond the range of typical reservoir elevations has a greater risk of continuing to progress upstream, eventually beyond the control of the reservoir water surface elevation. The threshold or criterion established for potentially significant impacts associated with channel bed incision is as follows:

> Reservoir elevation lowering below elevation 45,000 acre-feet (5,763.5 feet elevation) for more than two runoff seasons (March, April, May) represents a significant impact.

The two-season requirement acknowledges the fact that a head-cut beginning within the reservoir at any elevation below 45,000 acre-feet (5,763.5 feet elevation) must require some time (in association with high flows) before it can progress upstream to where it would affect the flowing channel reaches above the reservoir bed. In terms of applying the significance criteria, both the period of drawdown and refill are considered and counted. If the reservoir is initially drawn down so that it is below 45,000 acre-feet anytime during the first runoff season, then this is counted as one season during which head-cutting could be initiated. The DFG drawdown model was used to determine how long it would take for the reservoir to be drawn down to the project/action alternatives target levels and approximately at which date the critical elevation would be reached (see Appendix D).

Refill under any of the project/action alternatives may take one, two, three, or more years depending upon the amount of inflow to the reservoir during the runoff season. The likelihood that a given project/action alternative would refill within a certain number of years was evaluated using the DFG refill model (Appendix D).

The DFG refill model uses the historical regulated flow records since 1968 to simulate inflows to the reservoir and outflows for channel maintenance, evaporation, water rights requirements, and seepage. The model predicts the length of time needed to reach a refill elevation from a starting drawdown elevation that is associated with each of the alternatives. Depending upon the type of water year (i.e., wet, dry, average), it can take more or less time to reach a given refill target elevation. Using the modeled period of record, it is possible to estimate the percentage of years that a given refill target was reached.

The DFG refill model was used to estimate the average length of time it could take to refill the reservoir to 45,000 acre-feet (5,763.5 feet elevation), which is the threshold criteria for the bed incision analysis. It was assumed that, using the DFG model, that the reservoir elevation was at or higher than 45,000 acre-feet (5,763.5 feet elevation) by March 1 (beginning of runoff period) of the second runoff year (combining drawdown and refill years) at least 75 percent of the time, then head-cutting would not be a significant impact. If the reservoir is predicted to be at or higher than 45,000 acre-feet (5,763.5 feet elevation) less than 75 percent of the time in a second runoff season (March, April, or May), then there are significant impacts.

If significant impacts from any alternative were determined, then the project alternatives would be inconsistent with the SNFPA policies. Such impacts include loss of floodplain connection with the stream channel, erosion and degradation of the stream channel and possible loss of riparian, aquatic, wetland, and meadow habitats.

Structural Stability of Boat Ramps

The rate at which the water level in the reservoir is drawn down can be used to determine the potential for hydrostatic pressure to develop, which can then cause the boat ramps to crack and break. The faster the water level is drawn down, the greater the risk that reservoir sediment beneath the boat ramps will not drain quickly and the higher the potential for hydrostatic pressure to develop.

Based on discussion with experienced staff at Department of Boating and Waterways (DBW), it was determined that drawdown rates that lower the water surface elevation of the reservoir at a rate that is on the order of one foot per hour could be too fast to allow the reservoir sediments to drain (Scott McDonall, personal communication, 2006). Conversely, drawdown rates that are about one foot per day or slower should not pose a problem. Therefore, for purposes of this analysis, drawdown rates that are faster than one foot per day are assumed to create a situation that would threaten the structural stability of the boat ramps. The following significance criterion is established:

> Drawdown rates that are faster than one foot per day over any part of the existing boat ramps are deemed to be a significant impact on the structural stability of the ramps.

Drawdown rates are evaluated using the DFG drawdown model. The applicable drawdown rates are those that would occur over the length and elevation range of the boat ramps. The very lowest elevation is 5,762 feet elevation (41,000 acre-feet) at Honker Cove and the highest elevation is 5,779 feet at Mallard Cove. However, the Mallard Cove boat ramp begins above the spillway elevation of 5,775 feet and for purposes of this specific analysis, the expected highest reservoir level at the start of drawdown in January is 60,000 acre-feet (5,768.3 feet elevation). Therefore, the applicable elevation range for a conservative analysis is about 6 feet, from 5,768.3 to 5,762 feet elevation, although the project alternatives assume a reservoir starting level of 45,000 acre-feet.

3.1.2.3 No Project/No Action

The No Project/No Action (No Project) alternative would not change the current hydrologic conditions in Big Grizzly Creek, Lake Davis, and surrounding tributaries. Flows released from the dam would be the same as current flow conditions thus the potential for bank erosion along Big Grizzly Creek would not be an issue, i.e., no adverse impact. However, additional head-cutting and bank erosion of the tributaries may occur with the No Project alternative, as the reservoir elevation would be expected to continue to fluctuate between approximately 45,000 acre-feet storage or higher. In response to reservoir level fluctuations, the gradient and channel bed elevation would adjust by aggrading or incising.

Since there is no drawdown, there is no difference from recent reservoir level fluctuations during past years. There are no drawdown rates associated with No Project, which is equivalent to existing conditions. Therefore, the boat ramps are expected to remain structurally sound, and there is no impact.

3.1.2.4 Proposed Project/Proposed Action – 15,000 Acre-Feet (Plus Treatment)

Potential Bank Erosion on Big Grizzly Creek

The results of the drawdown model indicate that both the 45,000 acre-feet and 60,000 acre-feet starting storage volume can reach the 15,000 acre-feet target by October 1 of the first drawdown year in average runoff years. For most of the years, the target volume was met by the end of August. No auxiliary pumping is required to reach the drawdown target by October 1 during average or dry runoff years when the reservoir starts at 45,000 acre-feet.

A pumping rate of 50 to 100 cfs was necessary and assumed for the wetter than average years to increase the rate of drawdown in the reservoir so that the 15,000 acre-feet target could be reached. Table 3.1-9 shows the average daily flows expected for Big Grizzly Creek during drawdown in the selected wet, average, and dry years (1983, 1973, and 2001, respectively). These represent the years with the greatest, median, and driest inflow to Lake Davis based on DWR records, and therefore span the range of conditions that are likely to occur when the reservoir is drawn down. Because the amount and timing of inflow to Lake Davis during the treatment year cannot be predicted, the actual flows will vary from those provided. The DWR strainer will limit outflow from the reservoir to 145 cfs, plus the quantity of water pumped from the reservoir. None of the average daily flows exceed the 240 cfs criterion.

Table 3.1-9. Average Flows in Big Grizzly Creek during Drawdown to 15,000 Acre-Feet*

	Average Flow (cfs) January–March	Average Flow (cfs) April–June	Average Flow (cfs) July–September
Starting Volume 45,000 Acre-Feet			
Average Year	136	134	100
Wet Year	218	186	166
Dry Year	135	126	13
Starting Volume 60,000 Acre-Feet			
Average Year	140	137	130
Wet Year	214	214	209
Dry Year	139	173	74

*Assumed a maximum 145 cfs discharge from the dam, not including auxiliary pumping.

Table 3.1-10 shows the duration of the flows for the drawdown period in the selected average, wet, and dry years. The analysis indicates that in average and dry years, flows do not exceed 145 cfs. The results of the analysis show that none of the flows are over the 240 cfs significance criterion.

Table 3.1-10. Duration of Average Flows for Drawdown to 15,000 Acre-Feet

	Number of Days of Flow from January 1 to September 30					
	0-50 cfs	51-100 cfs	101–150 cfs	151–200 cfs	201–240 cfs	>240 cfs
Starting Volume 45,000 Acre-Feet						
Average Year	13	3	257	0	0	0
Wet Year	0	0	30	184	59	0
Dry Year	81	3	189	0	0	0
Starting Volume 60,000 Acre-Feet						
Average Year	0	0	273	0	0	0
Wet Year	0	0	0	0	273	0
Dry Year	34	4	235	0	0	0

Impact H-1: To accomplish reservoir drawdown from approximately 45,000 acre-feet or 60,000 acre-feet beginning in January, releases to Big Grizzly Creek would result in an average daily flow of 218 cfs or below for all water years. The impact on bank erosion for Big Grizzly Creek is less than significant.

Mitigation H-1: No mitigation is required.

Potential Tributary Incision and Head-cutting

Based on the significance criteria (Section 3.1.2.1) the potential for head-cutting occurs whenever the reservoir water surface elevation is below 5,763.5 feet. There is a potential for reservoir levels to be below the critical level during drawdown prior to June 1 during dry and average years.

During refill, the assumption is that the reservoir must return to the 5,763.5 feet elevation in at least 75 percent of the years by the second runoff season or the significance criterion is not met. Table 3.1-11 shows the likelihood of the reservoir returning to the 5,763.5 feet elevation critical level by the beginning of the peak runoff period (March 1) for the first six years following drawdown.

Table 3.1-11. Likelihood of Target Elevation Being Met Starting from 15,000 Acre-Feet

	Percent of Years in Which Storage is Greater than 5,763.5 Feet by March 1[1]
Year 1	6%
Year 2	61%
Year 3	76%
Year 4	82%
Year 5	88%
Year 6	94%

[1]Data based on DFG modeled flows for period of record.

The analysis shows that the reservoir would return to 5,763.5 feet elevation by the second runoff season only 61 percent of the time. Therefore, the tributaries have the potential to head-cut, and this is a significant impact.

Impact H-2: During the dewatering and refill period, there is a potential for tributary head-cutting for at least three runoff seasons. The impact of tributary head-cutting is significant but mitigable.

Mitigation H-2: Head-cutting could be mitigated during refill by establishing a monitoring program, prior to dewatering and continuing until the reservoir elevation is at or above 5,763.5 feet elevation, to identify new or migrating head-cuts. Then, after the reservoir has refilled, any new head-cuts identified by the monitoring program would be repaired.

Any substantial head-cuts or newly unstable banks, or indications of vertical channel instability should be used to define specific mitigation measures to stop head-cutting, restore bed elevations, and provide bank erosion control. The DFG may use methods currently employed by the USFS for stabilizing head-cuts and repairing bank erosion. These methods include: shaping banks and planting native riparian species. Other feasible mitigation measures include armoring head-cuts with cobble-size rip-rap to create a hard-point on the channel bed, or other grade control structures such as permeable check dams to aggrade any newly identified and substantially incised reaches. The upstream and downstream geographic boundaries of responsibility for addressing new areas of bed and bank instability should be determined in consultation with the USFS, but the downstream boundary would not extend below 5,774 feet elevation, which is within the range of water surface fluctuation of the reservoir as managed by the DWR and would not be associated with a flow channel reach in many years.

The monitoring program is provided in Section 3.1.2.14, Monitoring.

Significance After Mitigation: This measure is sufficient to reduce the impact to less than significant.

Instability of Boat Ramps

The fastest drawdown rate is approximately 218 cfs (Table 3.1-9), which corresponds to 432 acre-feet per day. Assuming a worst-case scenario, when there is no inflow to the reservoir, then the reservoir elevation would change by approximately 440 acre-feet per day. At this rate, starting at 60,000 acre-feet (5,768.3 feet elevation), it would take eight days to drop one foot in elevation to 56,480 acre-feet (5,767.3 feet elevation). The fastest rate of elevation loss would be for the lowest portion of the boat ramp at Honker Cove (5,762 feet elevation). From elevation 44,520, acre-feet (5,763.4 feet elevation) to elevation 41,000 acre-feet (5,762 feet elevation), the reservoir would drop 1.4 feet over eight days. This is much slower than the significance threshold of faster than one foot per day. Therefore, there are no impacts associated with this rate of drawdown.

Impact H-3: The rate of drawdown to reach 15,000 acre-feet is not greater than one foot per day. There is no impact of the Proposed Project on cracking or buckling of the boat ramps.

Mitigation H-3: No mitigation is required.

3.1.2.5 Alternative A – 15,000 Acre-Feet (Plus Treatment Including Powder)

The results for this alternative are exactly the same as for the Proposed Project/Proposed Action alternative of 15,000 acre-feet plus treatment shown above in Section 3.1.2.4.

3.1.2.6 Alternative B – 5,000 Acre-Feet (Plus Treatment)

Potential Bank Erosion on Big Grizzly Creek

The results of the drawdown model indicate that both the 45,000 acre-feet and 60,000 acre-feet starting storage volume can reach the 5,000 acre-feet target by October 1 of the first drawdown year in average runoff years. The target volume was met by the end of August for most of the modeled years. No auxiliary pumping was required to reach the drawdown target by October 1 during dry runoff years for either starting volume and average years starting with 48,000 acre-feet.

A pumping rate of 75 to 100 cfs was necessary and assumed for the wetter years and 50 cfs for the average year starting with 60,000 acre-feet. Pumping would be necessary by the summer months to increase the rate of drawdown in the reservoir so that the 5,000 acre-feet target could be reached. Table 3.1-12 shows the average daily flow in Big Grizzly Creek during drawdown. None of the average daily flows exceed the 240 cfs criterion.

Table 3.1-12. Average Flows in Big Grizzly Creek During Drawdown to 5,000 Acre-Feet*

	Average Flow (cfs) January-March	Average Flow (cfs) April-June	Average Flow (cfs) July-September
Starting Volume 45,000 Acre-Feet			
Average Year	136	134	100
Wet Year	235	218	186
Dry Year	135	126	13
Starting Volume 60,000 Acre-Feet			
Average Year	140	137	167
Wet Year	229	227	228
Dry Year	139	173	74

*Assumed a maximum 145 cfs discharge from the dam, not including auxiliary pumping.

Table 3.1-13 describes the magnitude and duration during the drawdown period for average, wet, and dry years. The results of the analysis show that regardless of water year type, none of the flows are over the 240 cfs significance criterion.

Table 3.1-13. Duration of Average Flows for Drawdown to 5,000 Acre-Feet

	Number of Days of Flow from January 1 to September 30					
	0–50 cfs	51–100 cfs	101–150 cfs	151–200 cfs	201–240 cfs	>240 cfs
Starting Volume 45,000 Acre-Feet						
Average Year	13	3	257	0	0	0
Wet Year	0	8	0	26	239	0
Dry Year	81	3	189	0	0	0
Starting Volume 60,000 Acre-Feet						
Average Year	5	0	183	85	0	0
Wet Year	0	0	0	0	273	0
Dry Year	34	4	235	0	0	0

Impact H-4: To accomplish reservoir drawdown from approximately 45,000 acre-feet or 60,000 acre-feet beginning in January, releases to Big Grizzly Creek would result in an average daily flow of 235 cfs or less for all water years. The impact on bank erosion on Big Grizzly Creek is less than significant.

Mitigation H-4: No mitigation is required.

Tributary Incision and Head-cutting

During drawdown, there is a potential for reservoir levels to be below the critical level prior to June 1 during dry and average years.

Table 3.1-14 shows the likelihood of the reservoir returning to the 5,763.5 feet elevation level by the beginning of the peak runoff period (March 1) for the first six years during refill. The analysis shows that the reservoir's return to 5,763.5 feet elevation in 75 percent of the modeled years by the second runoff season is not met. The reservoir would return to 5,763.5 feet elevation by March 1 of the second year following drawdown only 38 percent of the time. Therefore, the tributaries have the potential to head-cut, and this is a significant impact.

Table 3.1-14. Likelihood of Target Elevation Being Met Starting from 5,000 Acre-Feet

	Percent of Years in Which Storage is Greater than 5,763.5 Feet by March 1[1]
Year 1	0%
Year 2	38%
Year 3	69%
Year 4	78%
Year 5	91%
Year 6	94%

[1]Data based on DFG modeled flows for period of record

Impact H-5: During the dewatering and refill period, there is a potential for tributary head-cutting for at least four runoff seasons. The impact on tributary head-cutting is significant but mitigable.

Mitigation H-5: Mitigation would be the same as described for Impact H-2, Proposed Project/Proposed Action (drawdown to 15,000 acre-feet plus treatment).

Significance After Mitigation: This measure is sufficient to reduce the impact to less than significant.

Instability of Boat Ramps

The fastest drawdown rate is approximately 235 cfs (Table 3.1-12), which corresponds to 466 acre-feet per day. Assuming a worst-case scenario, when there is no inflow to the reservoir, then the reservoir elevation would change by approximately 466 acre-feet per day. At this rate, starting at 60,000 acre-feet (5,768.3 feet elevation) it would take 7.5 days to drop one foot in elevation to 56,480 acre-feet (5,767.3 feet elevation). The fastest rate of elevation loss would be for the lowest portion of the boat ramp at Honker Cove (5,762 feet elevation). From elevation 44,520 acre-feet (5,763.4 feet elevation) to elevation 41,000 acre-feet (5,762 feet elevation), the reservoir would drop 1.4 feet over 7.5 days. This is much slower than the significance threshold of faster than one foot per day. Therefore, there are no adverse impacts associated with this rate of drawdown.

Impact H-6: The rate of drawdown to reach 5,000 acre-feet is not greater than one foot per day. There is no adverse impact on cracking or buckling of the boat ramps.

Mitigation H-6: No mitigation is required.

3.1.2.7 Alternative C – 35,000 Acre-Feet (Plus Treatment)

Potential Bank Erosion on Big Grizzly Creek

The model results indicate that the 35,000 acre-feet target can be achieved by October 1 of the first drawdown year. The target elevation is usually met by June, except for wet years when the drawdown is achieved by the end of August. An auxiliary pumping rate of 50 to 75 cfs was necessary and assumed for wet years. Pumping would continue throughout the drawdown period and summer months to increase the rate of drawdown in the reservoir so that the 35,000 acre-feet target could be reached. Table 3.1-15 shows the average flows expected in Big Grizzly Creek during drawdown. None of the flows exceed the 240 cfs criterion.

Table 3.1-15. Average Flows in Big Grizzly Creek During Drawdown to 35,000 Acre-Feet*

	Average Flow (cfs) January-March	Average Flow (cfs) April-June	Average Flow (cfs) July-September
Starting Volume 45,000 Acre-Feet			
Average Year	136	134	100
Wet Year	137	157	187
Dry Year	135	126	13
Starting Volume 60,000 Acre-Feet			
Average Year	140	137	130
Wet Year	160	191	195
Dry Year	139	173	74

*Assumed a maximum 145 cfs discharge from the dam, not including auxiliary pumping.

Table 3.1-16 describes the magnitude and duration of flows during the drawdown period for the selected average, wet, and dry years.

Table 3.1-16. Duration of Average Flows for Drawdown to 35,000 Acre-Feet

	Number of Days of Flow from January 1 to September 30					
	0–50 cfs	51–100 cfs	101–150 cfs	151–200 cfs	201–240 cfs	>240 cfs
Starting Volume 45,000 Acre-Feet						
Average Year	13	3	257	0	0	0
Wet Year	0	0	151	122	0	0
Dry Year	81	3	189	0	0	0

Table 3.1-16. Duration of Average Flows for Drawdown to 35,000 Acre-Feet

	Number of Days of Flow from January 1 to September 30					
	0–50 cfs	**51–100 cfs**	**101–150 cfs**	**151–200 cfs**	**201–240 cfs**	**>240 cfs**
Starting Volume 60,000 Acre-Feet						
Average Year	0	0	273	0	0	0
Wet Year	0	0	0	243	30	0
Dry Year	34	4	235	0	0	0

Impact H-7: To accomplish reservoir drawdown from approximately 45,000 acre-feet or 60,000 acre-feet beginning in January, releases to Big Grizzly Creek would result in an average daily flow of 195 cfs or less for all water years. The impact on bank erosion on Big Grizzly Creek is less than significant.

Mitigation H-7: No mitigation is required.

Tributary Incision and Head-cutting

During drawdown there is a potential for reservoir levels to be below the critical level prior to June 1 during dry and average years. Table 3.1-17 shows the likelihood of the reservoir returning to the 5,763.5 feet level by the beginning of the peak runoff period (March 1) for the first six years during refill. The analysis shows that the goal of the reservoir's return to 5,763.5 feet elevation by the second runoff season in 75 percent of the modeled years is not met. The reservoir would return to elevation 5,763.5 feet by March 1 of the second year following drawdown 73 percent of the time. Therefore, this is considered a significant adverse impact.

Table 3.1-17. Likelihood of Target Elevation Being Met Starting from 35,000 Acre-Feet

	Percent of Years in Which Storage is Greater than 5,763.5 Feet by March 1[1]
Year 1	30%
Year 2	73%
Year 3	84%
Year 4	89%
Year 5	95%
Year 6	95%

[1]Data based on DFG modeled flows for period of record.

Impact H-8: During the dewatering and refill period, there is a potential for tributary head-cutting for at least three runoff seasons. The impact on tributary head-cutting is significant but mitigable.

Mitigation H-8: Mitigation would be the same as described for Impact H-2, Proposed Project/Proposed Action (drawdown to 15,000 acre-feet plus treatment).

Significance After Mitigation: This measure is sufficient to reduce the impact to less than significant.

Instability of Boat Ramps

The fastest drawdown rate is approximately 195 cfs (Table 3.1-15), which corresponds to 387 acre-feet per day. Assuming a worst-case scenario, when there is no inflow to the reservoir, the reservoir elevation would change by approximately 387 acre-feet per day. At this rate and starting at 60,000 acre-feet (5,768.3 feet elevation), it would take nine days to drop one foot in elevation to 56,480 acre-feet (5,767.3 feet elevation). The fastest rate of elevation loss would be for the lowest portion of the boat ramp at Honker Cove (5,762 feet elevation). From 5,763.4 feet elevation (44,520 acre-feet) to 5,762 feet elevation (41,000 acre-feet), the reservoir would drop 1.4 feet over nine days. This is much slower than the significance threshold of faster than one foot per day. Therefore, there are no adverse impacts associated with this rate of drawdown.

Impact H-9: The rate of drawdown to reach 35,000 acre-feet is not greater than one foot per day. There is no adverse impact of cracking or buckling of the boat ramps.

Mitigation H-9: No mitigation is required.

3.1.2.8 Alternative D – 48,000 Acre-Feet (Plus Treatment)

Potential Bank Erosion on Big Grizzly Creek

The model results indicate that the 48,000 acre-feet target can be achieved by October 1 of the first drawdown year. The assumed starting volume of 45,000 acre-feet is already below the target elevation for this alternative, and only incoming flows would need to be released downstream. The historical starting volume of 60,000 acre-feet can be drawn down to the 48,000 acre-feet target volume by August during wet years and February or March in dry or average years. Auxiliary pumping of 50 cfs is required to reach the drawdown target by October 1 when starting at 60,000 acre-feet. Table 3.1-18 shows the average outflows to Big Grizzly Creek. None of the flows exceed the 240 cfs criterion.

Table 3.1-18. Average Flows in Big Grizzly Creek for Drawdown to 48,000 Acre-Feet*

	Average Flow (cfs) January-March	Average Flow (cfs) April-June	Average Flow (cfs) July-September
Starting Volume 45,000 Acre-Feet			
Average Year	23	34	2
Wet Year	56	11	5
Dry Year	11	3	0.2

Table 3.1-18. Average Flows in Big Grizzly Creek for Drawdown to 48,000 Acre-Feet*

	Average Flow (cfs) January-March	Average Flow (cfs) April-June	Average Flow (cfs) July-September
Starting Volume 60,000 Acre-Feet			
Average Year	140	137	130
Wet Year	190	191	195
Dry Year	139	173	74

*Assumed a maximum 145 cfs discharge from the dam, not including auxiliary pumping.

Table 3.1-19 describes the magnitude and duration of flows during the drawdown period for an average, wet, and dry year. The results of the analysis show that none of the flows are over the 240 cfs significance criterion.

Table 3.1-19. Duration of Average Flows for Drawdown to 48,000 Acre-Feet

	Number of Days of Flow from January 1 to September 30					
	0–50 cfs	51–100 cfs	101–150 cfs	151–200 cfs	201–240 cfs	>240 cfs
Starting Volume 45,000 Acre-Feet						
Average Year	273	0	0	0	0	0
Wet Year	92	150	0	30	0	0
Dry Year	273	0	0	0	0	0
Starting Volume 60,000 Acre-Feet						
Average Year	0	0	273	0	0	0
Wet Year	0	0	0	243	30	0
Dry Year	34	4	235	0	0	0

Impact H-10: To accomplish reservoir drawdown from approximately 45,000 acre-feet or 60,000 acre-feet beginning in January, releases to Big Grizzly Creek would result in an average daily flow of 195 cfs or less for all water years. The impact on bank erosion on Big Grizzly Creek is less than significant.

Mitigation H-10: No mitigation is required.

Tributary Incision and Head-cutting

The target 48,000 acre-feet volume of the reservoir under this alternative is above the 5,763.5-foot threshold level at which head-cutting is likely to occur. Therefore, head-cutting is not a significant concern.

Impact H-11: The elevation of the reservoir is maintained above 5,763.5 feet, so the impact on tributary incision and head-cutting is less than significant.

Mitigation H-11: No mitigation is required.

Instability of Boat Ramps

The fastest drawdown rate is approximately 195 cfs (Table 13.1-18), which corresponds to 387 acre-feet per day. Assuming a worst-case scenario, when there is no inflow to the reservoir, the reservoir elevation would change by approximately 387 acre-feet per day. At this rate and starting at 60,000 acre-feet (5,768.3 feet elevation), it would take nine days to drop one foot in elevation to 56,480 acre-feet (5,767.3 feet elevation). The fastest rate of elevation loss would be for the lowest portion of the boat ramp at Honker Cove (5,762 feet elevation). From elevation 44,520 acre-feet (5,763.4 feet elevation) to elevation 41,000 acre-feet (5,762 feet elevation), the reservoir would drop 1.4 feet over nine days. This is much slower than the significance threshold of faster than one foot per day. Therefore, there are no adverse impacts associated with this rate of drawdown.

Impact H-12: The rate of drawdown to reach 48,000 acre-feet is not greater than one foot per day. There is no adverse impact on cracking or buckling of the boat ramps.

Mitigation H-12: No mitigation is required.

3.1.2.9 Alternative E – Dewater Reservoir and Tributaries (No Chemical Treatment)

Potential Bank Erosion on Big Grizzly Creek

The results of the drawdown model indicate that both the 45,000 acre-feet and 60,000 acre-feet starting storage volume can reach the completely dewater the reservoir target by October 1 of the first drawdown year in dry and average runoff years. The one exception is starting at 60,000 acre-feet when dewatering would be complete on October 2. For most of the years, the target volume was met by the middle of September. A pumping rate of 50 to 100 cfs was necessary and assumed for wet years and average years starting with 60,000 acre-feet of storage. Table 3.1-20 shows the average daily flows expected in Big Grizzly Creek for the selected average, wet, and dry years.

Table 3.1-20. Average Flows in Big Grizzly Creek to Completely Dewater Lake Davis*

	Average Flow (cfs) January-March	Average Flow (cfs) April-June	Average Flow (cfs) July-September
Starting Volume 45,000 Acre-Feet			
Average Year	136	134	100
Wet Year	136	227	190
Dry Year	135	126	13
Starting Volume 60,000 Acre-Feet			
Average Year	140	137	130
Wet Year	229	227	228
Dry Year	139	173	74

*Assumed a maximum 145 cfs discharge from the dam, not including auxiliary pumping.

Table 3.1-21 describes the magnitude and duration of flow releases to Big Grizzly Creek during the drawdown period for the selected average, wet, and dry years. None of the flows exceeded the 240 cfs criterion.

Table 3.1-21. Duration of Average Flows for Drawdown to Completely Dewater Lake Davis

	Number of Days of Flow from January 1 to September 30					
	0–50 cfs	51–100 cfs	101–150 cfs	151–200 cfs	201–240 cfs	>240 cfs
Starting Volume 45,000 Acre-Feet						
Average Year	13	3	257	0	0	0
Wet Year	0	8	0	26	239	0
Dry Year	81	3	189	0	0	0
Starting Volume 60,000 Acre-Feet						
Average Year	5	0	183	85	0	0
Wet Year	0	0	0	0	273	0
Dry Year	34	4	235	0	0	0

Impact H-13: To accomplish reservoir drawdown from approximately 45,000 acre-feet or 60,000 acre-feet beginning in January, releases to Big Grizzly Creek would result in an average daily flow of 236 cfs or less for all water years. The impact on bank erosion on Big Grizzly Creek is less than significant.

Mitigation H-13: No mitigation is required.

Tributary Incision and Head-cutting

During drawdown there is a potential for reservoir levels to be below the critical level prior to June 1 during dry and average years. Table 3.1-22 shows the likelihood of the reservoir returning to the threshold 5,763.5 feet level by the beginning of the peak runoff period (March 1) for the first six years during refill. The analysis shows that the goal of the reservoir's return to 5,763.5 feet elevation by the second runoff season in 75 percent of the modeled years is not met. The reservoir would return to 5,763.5 feet elevation by March 1 of the second year following drawdown only 25 percent of the time (Table 3.1-22). Therefore, this is considered a significant impact. The potential for head-cutting continues until the water in the reservoir is at 5,760 feet elevation or higher.

Table 3.1-22. Likelihood of Target Elevation Being Met Starting from Complete Dewatering

	Percent of Years in Which Storage is Greater than 5,763.5 Feet by March 1[1]
Year 1	0%
Year 2	25%
Year 3	66%

Table 3.1-22. Likelihood of Target Elevation Being Met Starting from Complete Dewatering

	Percent of Years in Which Storage is Greater than 5,763.5 Feet by March 1[1]
Year 4	75%
Year 5	88%
Year 6	94%

[1]Data is based on DFG modeled flows for period of record.

Impact H-14: During the dewatering and refill period, there is a potential for tributary head-cutting for at least four runoff seasons. The impact on tributary head-cutting is significant but mitigable.

Mitigation H-14: Mitigation would be the same as described for Impact H-2, Proposed Project/Proposed Action (drawdown to 15,000 acre-feet plus treatment).

Significance After Mitigation: This measure is sufficient to reduce the impact to less than significant.

Instability of Boat Ramps

The fastest drawdown rate is approximately 229 cfs (Table 3.1-20), which corresponds to 454 acre-feet per day. Assuming a worst-case scenario, when there is no inflow to the reservoir, then the reservoir elevation would change by approximately 454 acre-feet per day. At this rate it would take starting at 60,000 acre-feet (5,768.3 feet elevation), eight days to drop one foot in elevation to 56,480 acre-feet (5,767.3 feet elevation). The fastest rate of elevation loss would be for the lowest portion of the boat ramp at Honker Cove (5,762 feet elevation). From elevation 44,520 acre-feet (5,763.4 feet elevation) to elevation 41,000 acre-feet (5,762 feet elevation), the reservoir would drop 1.4 feet over eight days. This is much slower than the significance threshold of faster than one foot per day. Therefore, there are no adverse impacts associated with this rate of drawdown.

Impact H-15: The rate of drawdown to completely dewater the reservoir is not greater than one foot per day. There is no adverse impact on cracking or buckling of the boat ramps.

Mitigation H-15: No mitigation is required.

3.1.2.10 Consistency with Sierra Nevada Framework Plan Amendment

Bank Erosion on Big Grizzly Creek

- The Proposed Project and all project alternatives have less than significant adverse impacts.
- The goals of the SNFPA are consistent with the project alternatives, and no short-term or long-term impacts are identified.

Tributary Incision

- The Proposed Project and all action alternatives, except for Alternative D (48,000 acre-feet plus treatment), have significant but mitigable impacts.
- None of the project alternatives except Alternative D are consistent with SNFPA policies while the reservoir is below elevation 5,763.5 feet. The estimated length of time reservoir levels are below the critical elevation, tributary incision, bank erosion, disconnection with the surrounding floodplain, and lowering of the water table may occur. Once the reservoir refills to elevation 5,763.5 feet and mitigation is implemented, the project would be consistent with SNFPA policies.
- Alternative D would have a less than significant impact as it remains consistent with the SNFPA policies.

3.1.2.11 Cumulative Impacts

USFS Guidance provides the following NEPA definition (40 CFR 1508.7 and 1508.8): A cumulative impact is the impact on the environment that results from the incremental impact of the action when added to the impacts of other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes the other actions and regardless of land ownership on which the other actions occur. An individual action when considered alone may not have a significant impact, but when its impacts are considered in sum with the impacts of other past, present, and reasonably foreseeable future actions, the impacts may be significant. Under CEQA, Section 15355 says "cumulative impacts refer to two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts….Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time."

Analysis Area

The cumulative impacts analysis area includes the watershed area of Lake Davis and its tributaries and Big Grizzly Creek from below the dam to its confluence with the Middle Fork Feather River. The time frame for this analysis begins when drawdown of Lake Davis is initiated and extends until the lake has refilled to 5,763.5 feet elevation. The time until lake elevations are higher than 5,763.5 feet 75 percent of the time by March 1 varies from zero to three years depending on the alternative and runoff conditions following drawdown and treatment.

Projects Considered

Previous, present or future projects and actions (from Section 1.8, Related and Cumulative Analysis Programs and Projects) that were considered in this cumulative impact analysis for surface water resources include:

- USFS grazing allotments;
- Timber harvest – this includes numerous timber and salvage sales;

- USFS forest management practices (fuel reduction including timber harvest, thinning and group selection);
- Grizzly Ranch Development Project;
- USFS watershed restoration projects (Lake Davis and surrounding tributaries); and
- DBW boat ramp extensions.

For the purpose of this analysis, the Proposed Project and alternatives A and C would take a minimum of two runoff seasons and alternatives B and E would take a minimum of three runoff seasons to refill. In Alternative D the reservoir is not drawn down below the critical elevation, so no cumulative impacts are associated with this alternative.

Based on the Final EIS (Plumas County Planning Department 1989), the Grizzly Ranch Development Project (The Cedars) does not result in cumulative impacts in association with the Proposed Project. Surface drainage in the Grizzly Ranch Development Project area flows to the southwest to approximately 5,000 feet of stream on Big Grizzly Creek. Before surface drainage enters the creek, surface runoff enters grassy meadowlands to the west and east of the project area. The low slopes and high infiltration rates of the soils draining the Grizzly Ranch Development Project decreases the potential for increased runoff. There is no indication in the Final EIS that surface drainage magnitude or patterns would be altered. Therefore, there are no cumulative impacts from the Grizzly Ranch Development Project and the drawdown of Lake Davis.

This analysis describes the potential cumulative impacts of the Proposed Project and Alternatives A through E on geomorphology and hydrology when considered in combination with other past, present, and reasonably foreseeable actions and baseline conditions.

Effects of Other Projects

A brief description of the time period and likely impacts of other projects considered in this analysis is provided below.

USFS Grazing Allotments

Livestock grazing has been ongoing in the analysis area from the mid-1880s until the present. Intensive sheep and cattle grazing occurred through about the 1920s, when the Plumas National Forest began to manage cattle grazing allotments. Meadows and streams were degraded, including substantial erosion of surface soils. With fewer cattle permitted, and implementation of watershed restoration projects since the 1980s, there has been a slow recovery in the watershed. However, it is assumed that the impacts of continued cattle grazing are substantial and include significant soil erosion resulting in gullies, head-cutting, and channel bank erosion.

Timber Harvest Projects

As with cattle grazing, the effects of timber harvesting in the analysis area date back to the early 1900s and continue to the present. Timber harvesting impacts soils through road, skid and landing construction; displacement of topsoil; and loss of soil due to surface erosion. The impacts include increased runoff, gully erosion, and potential incision of tributaries.

USFS Forest and Fuels Management Projects

In addition to timber harvest projects, the USFS conducts forest and fuels management activities in the analysis area. This includes tree removal to reduce fire hazard, thinning for forest health, salvage cutting, pole cutting, tree planting, public fuel wood-cutting, and prescribed burns. These type of activities have occurred from about 1980 to the present. The impacts are assumed to be similar, but much less substantial, than timber harvest activities.

USFS Watershed Restoration Projects (Westside Lake Davis and surrounding tributaries)

The USFS performed a variety of restoration projects in Freeman Creek and Cow Creek from 1980 to 2000. Restoration activities included livestock enclosures, bank stabilization, willow planting, road closures, reseeding of disturbed areas, and filling in or stopping head-cuts and gullies. Although these projects are assumed to have reduced soil erosion and discharge problems in these areas, thus reducing bank erosion and incision in the tributaries and Lake Davis, erosion and head-cutting problems still exist.

DBW Boat Ramp Extensions

If boat ramp extensions occur at the same time as the Lake Davis project in 2007, then there would be no cumulative impacts.

The current lengths of the boat ramps are too short to use during low reservoir levels. The USFS proposed to extend the boat ramps in 2007 to maximize the boating facilities. To complete this project, the reservoir elevations need to be lowered below the lowest elevation of the proposed boat ramp extension for construction activities.

Proposed Project and Alternative A

The Proposed Project and Alternative A include one potential surface water impact: tributary incision. The structural stability of the boat ramps are not influenced by the other projects listed; therefore, there would be no cumulative impact.

The six past, present, or future projects listed below are considered to be cumulatively considerable, i.e., are considered substantial in combination with the Proposed Project.

Tributary Incision

- Grazing, timber removal, and various land management practices decrease ground cover, increasing runoff and increasing the potential for erosion and incision on the tributaries. Monitoring and mitigation for bank erosion is suggested, but through cumulative impacts, any bank erosion or head-cutting may be accentuated as a result of these additional projects.

- The past and current watershed restoration projects may be undermined as a result of lowered reservoir levels for an extended period of time. During the lowered reservoir level, bank erosion could occur near and undermine erosion control structures put in place to stop bank erosion. In addition, locations with bank erosion identified for repair may increase in size, increasing the cost and equipment required to stop the erosion.
- Extension of the boat ramps or maintenance requires the reservoir to be drawn down below the critical elevation of 5,763 feet during the peak runoff season (March–May) where there is a potential for head-cuts to continue upstream. Head-cuts may occur on the tributaries when the reservoir is below the average elevation of 5,767 feet. Although the extent of the head-cuts is uncertain, there is a possibility that any head-cuts can be inundated by the rising reservoir elevation, resulting in no noticeable impact. However, if the reservoir has to be drawn down again, the drowned head-cuts may again be exposed and then could continue upstream to a point above the average reservoir elevation. Once this occurs, the head-cut would continue until erosion control measures take place or a natural hard point (bedrock) is encountered.

Alternative B

The types of cumulative impacts for Alternative B are the same as described above for the Proposed Project and Alternative A. The magnitude and duration of tributary incision may be larger due to the longer estimated period of time the reservoir is drawn down below the critical level.

Alternative C

The types of cumulative impacts for Alternative C are the same as described above for the Proposed Project and Alternative A. The magnitude and duration of tributary incision may be similar or slightly less due to the similar estimated period of time the reservoir is drawn down below the critical level.

Alternative D

There would be no cumulative impacts for Alternative D, as the reservoir is not drawn down below the critical level. Any associated head-cutting or tributary erosion is a result of other projects in the vicinity and not directly related to Alternative D.

Alternative E

The types of cumulative impacts for Alternative E are the same as described above for the Proposed Project and Alternative A. The magnitude and duration of tributary incision may be larger due to the longer estimated period of time the reservoir is drawn down below the critical level.

3.1.2.12 Environmental Impacts Summary

A summary comparison of impacts is provided in Table 3.1-23 and summarized below.

Table 3.1-23. Summary Comparison of Impacts of Alternatives

Affected Resource and Area of Potential Impact	Alternative						
	No Project Compared to Existing Conditions	Proposed Project	A	B	C	D	E
Water Resources: Geomorphology and Hydrology							
1. Bank Erosion	N	LS, A	LS, A	LS, A	LS, A	LS, A	LS, A
2. Tributary Incision	N	SM, A	SM, A	SM, A	SM, A	LS, A	SM, A
3. Structural Stability of Boat Ramps	N	N	N	N	N	N	N

Key:

A = Adverse Impact (NEPA)
B = Beneficial Impact (NEPA)
LS = Less than Significant Impact (CEQA)
N = No Impact (CEQA, NEPA)
SM = Significant but Mitigatable Impact (CEQA)
SU = Significant and Unavoidable Impact (CEQA)

Bank Erosion on Big Grizzly Creek

- The Proposed Project and all project alternatives have less than significant impacts.

Tributary Incision

- The Proposed Project and the project alternatives, except for Alternative D (48,000 acre-feet plus treatment) have significant but mitigable impacts.
- Alternative D has a less than significant impact.

Stability of Boat Ramps

- The Proposed Project and all project alternatives have no impact.

3.1.2.13 Monitoring

Mitigation actions will rely on a monitoring program to identify whether incision and channel instability have occurred as a result of project implementation.

Tributary incision is a significant but mitigable impact. The extent to which tributary incision would actually occur is highly dependent upon the interplay of several factors, including: (a) runoff conditions during the drawdown and refill periods, (b) length of time the reservoir is drawn down, and (c) the specific geomorphic characteristics of each tributary stream (such as channel gradient, bank angle, presence of riparian vegetation, etc.). Actual runoff conditions that would occur during the drawdown and refill periods cannot be definitively known before the Proposed Project or any other alternative is implemented.

The site-specific geomorphic characteristics of the numerous tributaries draining to the reservoir are also not well known. This makes it difficult to predict the degree of individual tributary adjustments, or to determine the likely extent of incision and accompanying bed and bank instability and erosion for each tributary, beforehand. This is a substantial constraint on developing feasible mitigation measures prior to project implementation. Therefore, the first step in mitigation actions should rely on a monitoring program to identify site-specific locations of incision and channel instability associated with most of the project/action alternatives. If site-specific locations of incision and instability are identified during monitoring following project implementation, then appropriate mitigation measures can best be designed and implemented. It is both impractical and infeasible to implement mitigation measures to control potential tributary incision before project implementation.

A monitoring program would begin prior to drawdown to identify baseline tributary conditions. There are a total of 18 tributary streams to be monitored. Monitoring is not required if Alternative D (48,000 acre-feet) is the selected project, since it is assumed that the tributaries are nearly graded to this reservoir elevation and no impacts are identified. The USFS collected data to identify the locations of head-cuts on tributaries draining to the reservoir from the west side. These data should be utilized for the monitoring program. Existing head-cuts and unstable bank locations should be confirmed prior to initiating the project. The USFS would be monitoring potential new channel incision on streams where they have previously identified head-cuts and have performed restoration work. Beginning in 2007 the USFS is planning to repair existing head-cuts and bank erosion sites on these streams. The USFS monitoring would consist of visual observations in the late spring or early summer annually for the first three years. At each restoration site a photo of the structure, bank or revegetation work would be used to document the completed work. In addition, an upstream and downstream photo would be taken. The DFG would rely upon the USFS monitoring of these streams to identify existing and any potential new head-cuts.

The DFG would conduct monitoring, similar to that performed by the USFS for all tributaries that are not monitored by the USFS. This would include all solid blue-line streams (e.g. perennial streams) shown on the USGS topographic 7.5-minute quad on the east and west side of Lake Davis that are not already being monitored by the USFS. At a minimum, monitoring would include visual observation and supporting photographic documentation of channel conditions between approximately 5,774 feet and 5,776 feet (1-foot below to 1-foot above full pool elevation). Existing head-cuts identified within these boundaries prior to draw-down should be mapped and the height of the head-cut measured. The DFG would also establish at least one temporary elevation benchmark on each channel, preferably at or above the full-pool elevation (5,775 feet), within existing channel banks. This temporary elevation benchmark provides additional information on the elevation of the channel bed. The benchmark can be simple, for example a single piece of rebar driven horizontally into the bank. The distance from the rebar down to the channel bed is measured and recorded prior to project implementation. During the drawdown period, and until the reservoir is refilled, the distance to the channel bed is remeasured at the rebar benchmarks. If there is any incision in the channel where the benchmark is installed, then the distance to the channel bed would increase.

During the drawdown and refill periods, the tributary channels would be monitored by visual inspection, comparison to baseline photographs prior to the project drawdown, and by re-measuring the temporary benchmarks by the end of each spring runoff period (approximately June 1), snow and weather conditions permitting access. Any new areas of instability and head-cutting, or bank erosion would be photographically documented and unstable areas mapped. Once the reservoir has refilled, the temporary benchmarks should be re-measured, and final visual observations made, with photographic documentation. This information should be compared with the pre-project survey, in order to detect changes in bed elevation attributable to the project.

3.2 Surface Water Quality

The water quality impact analysis considers mechanisms by which surface water quality would be potentially affected by the Proposed Project and alternatives for drawdown and implementation activities, as well as effects of the chemical treatment and neutralization applications. However, all surface water quality issues related directly to rotenone formulation constituents and the neutralization agent, potassium permanganate, are discussed in Section 14, Human and Ecological Health Concerns.

3.2.1 Environmental Setting/Affected Environment

This section describes existing surface water quality conditions for Lake Davis, its major tributaries, and Big Grizzly Creek below Lake Davis. The discussion is based on data and information available from previous studies and monitoring programs. Water quality data collected during the 1997 Lake Davis rotenone treatment is also described and discussed. These two types of data provide information on both baseline condition and treatment conditions for surface water quality.

Water quality parameters are described using available data. Sources of existing surface water quality information in the project area include:

- Department of Water Resources (DWR) monitoring results for Lake Davis and Big Grizzly Creek;
- US Forest Service (USFS) water temperature monitoring in tributaries to Lake Davis;
- DWR 1971 Lake Davis Basin Water Quality Investigation Report;
- De Lain 1983 report on the limnology of Lake Davis; and
- DFG report of chemical residues following the 1997 Lake Davis rotenone treatment.

3.2.1.1 Water Quality of Project Area and Vicinity

Tables and figures relevant to this section are included in Appendix F, Surface Water Quality Information.

Baseline Conditions

The geologic setting of the Lake Davis watershed largely influences existing water quality conditions in Lake Davis, its tributaries, and Big Grizzly Creek below the dam. Lake Davis occupies the former site of ancient Lake Grizzly, which was a large and deep lake (DWR 1971). Silt and clay deposits derived from surrounding volcanic rocks formed extensive lake deposits that are now found adjacent to Lake Davis. Recent alluvial deposits derived from the surrounding lake deposits and volcanic rocks now form the underlying substrate of Lake Davis and its tributaries (DWR 1971). The volcanic origin of the easily erodable fine-grained lake deposits and more recent alluvial deposits has created a relatively fertile watershed and moderately productive condition for Lake Davis. This conclusion was supported by an evaluation of several indicators of trophic status that place Lake Davis in the mesotrophic category (moderate level) of lake productivity (De Lain 1983).

The earliest water quality monitoring in Lake Davis, its tributary streams, and Big Grizzly Creek below the reservoir following dam construction and impoundment was conducted between 1966 and 1970 by DWR and the Plumas County Health Department (DWR 1971). Similar monitoring was again conducted by DWR in 1972 (DWR 1973). The purpose of these studies was to characterize baseline water quality condition in the Lake Davis basin. In 1980–1981 a limnologic study of Lake Davis and its tributaries was conducted to characterize water quality conditions in relation to habitat quality for salmonids (De Lain 1983).

Water quality monitoring data for Lake Davis and Big Grizzly Creek below the dam are available from DWR for the period of 1973 through 2005 (WDL 2006). Archived data from 1973-1996 can be obtained from the DWR. The 1996 to 2005 data provide a more current characterization of water quality condition in the reservoir from spring through fall during these years. Temperature monitoring data for 2002, 2003, and 2005 are available from the USFS for three Lake Davis tributaries: Freeman Creek, Cow Creek, and Grizzly Creek.

Tributaries to Lake Davis

The main tributaries to Lake Davis include Big Grizzly Creek, Freeman Creek, Cow Creek, and several smaller, unnamed ephemeral streams. Water quality information for these tributaries is limited and consists mostly of historic data (DWR 1971, DWR 1973). The DWR collected physical and chemical water quality data including temperature, dissolved oxygen, pH, specific conductance, minerals and turbidity from 1967-1972 (Appendix F, Table F-1). From these studies, DWR characterized the streams as generally alkaline (pH>7), of calcium-magnesium bicarbonate type, and of low to moderate hardness. Dissolved oxygen concentrations ranged from 6.2 mg/L to 9.6 mg/L; specific conductance ranged from 20 to 150 µS/cm; and pH ranged from 6.7 to 8.2. Mineral and nutrient constituents were within the normal range for natural waters (Table F-1). The data from these studies indicates high quality water for Lake Davis tributaries.

Nutrient information was obtained from several Lake Davis tributaries during a limnologic study in 1980–1981 (De Lain 1983). The data from this study showed that nitrate, phosphate and phosphorus concentrations were notably higher in the tributaries during spring runoff conditions and ammonia was somewhat higher during summer conditions (Table F-2). In general, the tributary nutrient concentrations recorded during this study are in a moderate range.

The U.S. Forest Service (USFS) has monitored water temperatures in Freeman Creek, Cow Creek, and Big Grizzly Creek during the summer seasons of 2002 and 2003. Temperature data for Freeman Creek was also available for 2005. The temperature data were collected during approximately June through September using in-situ temperature loggers programmed to record the water temperature once every hour. Line plots of the water temperature data by stream and by year are provided in Figures F-2 and F-3. Summer water temperatures ranged from 44.6 to 82.4°F (7 to 28ºC) and peaked during mid to late July in the range from 50 to 59°F (23 to 28ºC). Diurnal water temperatures varied by 73.4 to 82.4°F (10 to 15ºC).

Lake Davis

The main sources of water quality information for Lake Davis include two historic DWR studies (DWR 1971, DWR 1973), a 1980-1981 limnologic study (De Lain 1983), and a DWR water quality data set that is available for 1996-2005 (WDL 2006). For the purpose of this EIR/EIS, a general summary of water quality findings from the early studies is provided with a minimum of the detailed water quality data available in those reports. Water quality results from the DWR’s 1996-2005 WDL data set are provided in detail in Tables F-3 to F-6.

The DWR and Plumas County performed a water quality investigation in 1970 to characterize baseline water quality conditions in Lake Davis (DWR 1971). The DWR and

USFS conducted a subsequent, similar study in 1972 (DWR 1973). Physical, chemical and biologic data were collected in an effort to provide a comprehensive understanding of existing water quality conditions. The study showed that typical physical, chemical and biological water quality processes occur in Lake Davis. The measured chemical parameters were within normal concentrations and ranges.

The most current available physical and chemical water quality data for Lake Davis are provided in Tables F-3 to F-6. The DWR collects this information annually from spring through fall at a monitoring station near the east end of the dam. Typical turbidity values for Lake Davis are in the range from 1.0 to 3.5 NTUs, with values sporadically reaching up to 8–9 NTUs (Table F-3). Results of trace metals analyses are typically less than laboratory detection limits or well below any levels of concern (Table F-4). Higher concentrations were often observed in the lower water column during mid-summer but still did not exceed human health or aquatic life criteria. Similarly, analytical results for nutrients (Table F-5) and dissolved ions (Table F-6) were well within normal and expected concentrations.

The annual patterns and fluctuations in physical and chemical water quality properties are of particular interest in lakes and reservoirs. As with most lakes and reservoirs, Lake Davis undergoes thermal stratification on a predictable and regular basis. Thermal stratification occurs in the summer when surface water temperature increases to the extent that a warmer, less dense water layer (epilimnion) overlays a cooler, more dense layer (hypolimnion) and there is no circulation or mixing between the two. The zone in the water column where water temperature drops relatively rapidly with depth is called the metalimnion. Thermal stratification occurs for a period of time during both the summer and winter seasons (although the processes during winter and summer are quite different) with periods of mixing and relatively constant water column temperature in the spring and fall.

Results from Lake Davis studies show that summer stratification typically begins to develop in May, is well-developed from June through August, begins to break down in September and has completely diminished by October (DWR 1971, De Lain 1983). This period will vary somewhat with annual climate variation. Summer stratification in Lake Davis is illustrated in the temperature profile plots for 1996 to 2005 shown in Figures 4a, 4b, and 4c. For example, in 1999 stratification had clearly begun in May and was well-defined in July, with water temperature ranging from 73.4°F (23ºC) at the surface to 51.8°F (11ºC) at the bottom. The metalimnion began at about 5 meters deep and extended to about 10 meters with a temperature drop of about 46.4°F (8ºC). By September, the thermocline (plane of rapid temperature decrease) was beginning to lower and weaken, it was mostly gone in October and by November the water temperature was essentially the same throughout the water column. The line plots for 2000 and 2005 are also good examples of this phenomenon (Figures 4a, 4b, and 4c).

Other physical and chemical water quality characteristics of Lake Davis undergo changes during periods of thermal stratification. Without downward mixing, dissolved oxygen concentrations in the hypolimnion are greatly reduced and often reach zero (anoxia). Degradation of organic matter is the primary cause of oxygen depletion in the hypolimnion. As shown in Figures 5a, 5b, and 5c, Lake Davis dissolved oxygen concentrations show a rapid vertical drop in the water column during June through September, with a typical range of 8 mg/L at the surface to near-zero or zero mg/L at the bottom. This rapid vertical drop in dissolved oxygen often occurs within a vertical distance of only 1 to 2 meters. Typically the epilimnion also experiences some dissolved oxygen reductions (e.g., 8 to 9 mg/L in May to 6 to 7 mg/L in September) during summer due to warming and bacterial activity, but does not drop as low as bottom waters (Figures 5a, 5b, and 5c). Oxygen concentrations in the epilimnion can also fluctuate rapidly on a daily basis in relation to biochemical processes at the surface.

A typical rate of oxygen depletion in Lake Davis (-0.12 mg/L per day) can reduce hypolimnetic oxygen from 100 percent saturation to zero percent saturation within 70 to 80 days (De Lain 1983). In a typical year the hypolimnion is anoxic by mid-July. A water level reduction in Lake Davis reduces the thickness and thus the total volume of the hypolimnion. This, in turn, reduces the total amount of dissolved oxygen initially available and results in a more rapid depletion of oxygen in the bottom of the reservoir. De Lain (1983) calculated the relationship between the original volume and the reduced volume of the hypolimnion under two drawdown scenarios. Assuming an average elevation of 1,759 meters, the hypolimnion would typically be about 10 meters deep. Because the depth to the hypolimnion does not change, a 10,000 acre-feet drawdown decreases the volume of the hypolimnion by 29 percent. Similarly, a 20,000 acre-feet drawdown decreases the volume by 50 percent.

Specific conductivity, which relates directly to total dissolved solids, also exhibits changes in relation to summer stratification. Because dissolved oxygen becomes extremely low in the lower water column, many chemical elements normally bound to the sediment go into solution, which raises specific conductivity. In addition, decomposition of organic materials in the hypolimnion also raises specific conductivity. The line plots in Figures 6a, 6b, and 6c illustrate the typical range of values for specific conductance between the surface and bottom of the water column. For example, in 1998 surface values were about 75 to 80 µmhos/cm at the surface and as high as 130 µmhos/cm at the bottom.

Another important water quality parameter that is altered during thermal stratification is pH. The typical pH values for Lake Davis range from 7.0 to 8.5. During periods of stratification, pH in the lower portion of the water column is often 1.5 to 2 units lower than surface waters (Table F-3). Because the alkalinity of Lake Davis is low (30 to 42 mg/L), the water has little buffering capacity resulting in easily altered pH (De Lain 1983, WDL 2006). There are two processes that create this wide range of pH values. Increased carbon dioxide and accumulation of carbonic acid in the lower water column (resulting from organic decomposition processes) cause reduced pH (DWR 1971), with pH readings of less than 7.0 found at depth. At the same time that pH is reduced in the lower water column, it is elevated in the surface waters. This is caused by photosynthetic activity of algae and aquatic macrophytes, which remove carbon dioxide during daylight hours, resulting in lower concentrations of carbonic acid and bicarbonates and elevated pH. Values of 8.5 to 9 and above have been observed in Lake Davis (DWR 1971, De Lain 1983, WDL 2006); see Table F-3.

Iron, manganese, and phosphorus are some of the chemical constituents that can be found in high concentrations at depth in the lake during periods of stratification (DWR 1971). Ammonia, ammonium hydroxide and hydrogen sulfide also accumulate in the hypolimnion due to anaerobic bacterial activity (DWR 1971, De Lain 1983). Data showing increased summer concentrations of ammonia and phosphorus are presented in Table F-7. Ammonia levels can also increase in the epilimnion and littoral zones due to bacterial decomposition of organic matter (De Lain 1973). High ammonia levels, in combination with high pH and water temperature, causes ammonium hydroxide concentrations to increase substantially This can be very toxic to fish, or at a minimum causes physiological stress. These effects are often compounded by low dissolved oxygen concentrations. This process is known to occur in Lake Davis during the summer season. Critically high levels of ammonium hydroxide were observed during water quality monitoring conducted in Lake Davis during 1970, 1980, and 1981 (De Lain 1983).

The growth cycles of algae and aquatic macrophytes are also important influences on water quality condition in Lake Davis. Because Lake Davis is nitrogen sensitive, pulses of nitrate that enter the lake from tributaries during spring runoff and from thermal mixing typically cause an algae bloom in early spring (DWR 1971, De Lain 1983). Elevated nutrient concentrations have been observed in Lake Davis tributaries during spring (De Lain 1983) (Table F-2). The early spring algae bloom reduces nitrate levels in Lake Davis until the bloom collapses in about May. After the algae die-back, tributary runoff again replenishes nitrate levels in the reservoir. Following the onset of summer stratification, nitrate is again depleted as blue-green algae become dominant (De Lain 1983). During the fall period of thermal mixing, nutrients are again released from the hypolimnion, resulting in a significant fall algae bloom (De Lain 1983). Algae decomposition in Lake Davis is a significant contributor to oxygen depletion in the hypolimnion.

Extensive macrophyte growth (rooted aquatic plants) in Lake Davis, during mid to late summer, contributes to elevated pH and ammonia concentrations in the littoral zone. During peak growth it has been estimated that aquatic plants cover all areas of the lake less than 15 feet deep, which represents about 40 percent of the lake surface (DWR 1971). A DFG survey conducted in August and September of 2003 indicated that dense growth of aquatic macrophytes was present in about 20 percent of the reservoir area. When these plants die back during fall and winter they will return nutrients to the aquatic system. During their 1970 survey DWR found that about 85 percent of the plant growth consisted of leafy pondweed (*Potamogeton foliosus*), about 5 to 8 percent was American pondweed (*Potamogeton nodosus*), and the remainder was a mixture of bulrush (*Scripus* sp.), spike rush (*Eleocharis* sp.) and *Myriophyllum* (species not identified) (DWR 1971). A more recent aquatic vegetation survey conducted by DFG in 2001 found a somewhat different species composition present. The species included waterweed (*Elodea* spp.), coontail (*Ceratophyllum demersum*), pondweed (*Potomageton* spp.), water buttercup (*Ranunculus aquatilus*), and arum-leaved arrow-head (*Sagittaria cuneata*).

Big Grizzly Creek Below Lake Davis

Water quality monitoring results for Big Grizzly Creek below Grizzly Valley Dam are available for 1967–1970 (Table F-1) and 1998–2005 (Tables F-8 to F-11). Analytical results for trace elements were generally less than laboratory detection limits or any levels of concern for human health or aquatic life (Table F-8). Nutrients (Table F-9) and dissolved ions (Table F-10) were also within normal and expected concentrations. Results for in-situ measurements (Table F-11) from 1998 to 2005 were as follows:

- Dissolved oxygen concentrations typically ranged from 7 to 10 mg/L with only two readings below 7 mg/L);
- Water temperature ranged from 39.2°F to 76.5°F (4ºC to 24.7ºC);
- pH ranged from 7.1 to 8.1;
- Specific conductance ranged from 44-120 µS/cm; and
- Turbidity, collected only in 2005, ranged from 1.6-2.6 NTUs.

All water quality monitoring results indicate good water quality conditions for Big Grizzly Creek below the dam.

Lake Davis 1997 Rotenone Treatment Conditions

During the 1997 rotenone treatment of Lake Davis, the Regional Water Quality Control Board (RWQCB) required monitoring of water quality conditions in Lake Davis and Big Grizzly Creek below the dam (RWQCB 1997). The RWQCB requirements included monitoring of chemical constituents in the rotenone formulation, dissolved oxygen, pH, biochemical oxygen demand (BOD), water temperature, hardness, total organic carbon (TOC), ammonia, specific conductivity, alkalinity, and bioassays using rainbow trout.

The results of the 1997 chemical monitoring for rotenone and associated constituents in the Nusyn-Noxfish® formulation are discussed in Section 14, Human and Ecological Health Concerns. No further reference to those results is made in this section.

Water quality in Lake Davis was measured by DFG in August and October 1997 before treatment, one week after treatment, and three weeks after treatment (Siepmann and Finlayson 1999). Alkalinity, hardness, total organic carbon, conductivity, ammonia, and pH were apparently not impacted by the treatment (Tables F-12 and F-13). Concentrations of these constituents during the treatment period were similar to the baseline results described above for Lake Davis. The BOD analyses, indicating elevated BOD levels for the week following treatment, were considered questionable possibly due to the presence of rotenone (Siepmann and Finlayson 1999). Three weeks after treatment, BOD was lower than it had been prior to treatment. However, the one-week post-treatment BOD results could have reflected an actual increase in BOD. Other studies have shown that dissolved oxygen concentrations are reduced substantially during rotenone treatments (DFG 1988, DFG 1994). The following statement from DFG's 1994 Programmatic EIR summarizes BOD and dissolved oxygen effects during rotenone treatments:

"The application of rotenone will temporarily lower the dissolved oxygen level in treated water, particularly in impoundments. This reaction stems from the chemical oxygen demand associated with the degradation of active and "inert" ingredients in the formulation. Additionally, the decomposition of dead fish will create a biological oxygen demand . . . . . Dissolved oxygen levels in previous chemical treatments have returned to normal by natural processes (i.e., phytoplankton production, dilution with untreated water, and exchange with the atmosphere) by the time the water had detoxified."

Grizzly Valley Dam Outflow Curtailment Impact Study

From October 4–7, 2005, DFG conducted a flow curtailment study for Big Grizzly Creek below the Grizzly Valley Dam. The purpose of the study was to determine the downstream impacts to aquatic habitat and organisms as a result of interrupting controlled water release from the dam. The only discharge from the dam was about 4 gpm from two “weep holes” in the dam. As part of the flow curtailment study, dissolved oxygen and temperature were monitored at six stations along Big Grizzly Creek. Results of the monitoring are presented in Table F-14. It appears that dissolved oxygen decreased significantly in the few pools nearest Grizzly Valley Dam, but decreased only slightly at more distant sampling points. The data also indicates that water temperatures were lower during the study period.

3.2.1.2 Regulatory Environment

Water quality standards for the Sacramento River Basin (and tributaries) are established by the Central Valley Water Quality Control Board. Designated beneficial uses and associated water quality objectives are set forth in the *Water Quality Control Plan for the Sacramento River Basin and the San Joaquin River Basin* (Basin Plan). Designated beneficial uses for Lake Davis include contact and non-contact recreation, cold freshwater habitat, spawning habitat, and wildlife habitat. Water quality standards related to these beneficial uses will apply to the Proposed Project and can be considered thresholds by which to evaluate impacts. The water quality parameters of concern for this project include turbidity, dissolved oxygen, pH, water temperature, bacteria, and nutrients.

The Sierra Nevada Framework Plan Amendment sets forth various goals, objectives, and guidelines for managing aquatic, riparian, and meadow ecosystems and their associated species. Of particular relevance to the environmental issues addressed and evaluated in this section are several of the objectives listed in the Record of Decision (ROD), Appendix A: Management Direction.

Under the ROD Aquatic Management Strategy, the water quality goal is to maintain and restore water quality to meet the goals of the Clean Water Act and Safe Drinking Water Act, providing water that is fishable, swimmable, and suitable for drinking after normal treatment. The Riparian Conservation Objective #1 is as follows:

- Ensure that identified beneficial uses for the water body are adequately protected.
- Identify the specific beneficial uses for the project area, water quality goals from the Regional Basin Plan, and the manner in which the standards and guidelines will protect the beneficial uses.

A related guideline that is applicable to this project is to ensure that management activities do not adversely affect water temperatures necessary for local aquatic and riparian-dependent species assemblages.

3.2.2 Environmental Impacts and Consequences

3.2.2.1 Evaluation Criteria and Environmental Concerns

Seven impact concerns have been defined for water quality:

- Elevated turbidity resulting from erosion caused by head-cutting of tributaries and incision of lake sediments;
- Anoxic reservoir condition developing earlier in the summer season;
- Reduced dissolved oxygen concentrations throughout the water column caused by chemical oxygen demand as a result of rotenone degradation;
- Reduced dissolved oxygen concentrations throughout the water column caused by biological oxygen demand as a result of the decomposition of dead fish;
- Elevated bacterial levels associated with the decomposition of dead fish;
- Reduced flows in Big Grizzly Creek during the treatment period (under the Proposed Neutralization Method and Neutralization Alternatives A and B) could result in decreased dissolved oxygen concentrations and increased water temperatures in Big Grizzly Creek; and
- Elevated turbidity, nutrients or water temperatures caused by erosion in tributary streams, vegetation removal, cofferdam construction, and creation of new access roads (applies only to Alternative E).

Evaluation Criteria

The significance criteria for evaluating water quality impacts resulting from the Proposed Project and project alternatives are based on the following considerations. In accordance with CEQA Mandatory Findings of Significance and agency and professional standards, a project impact would be considered significant if the project would:

- Substantially degrade environmental quality;
- Violate any water quality standards or waste discharge requirements;
- Substantially alter the existing drainage pattern in a manner which would result in substantial erosion or siltation;
- Create or contribute runoff water which would provide substantial sources of polluted runoff; or
- Otherwise substantially degrade water quality.

The project needs to comply with specific waste discharge requirements developed by the Central Valley Regional Water Quality Control Board. Issues of water quality criteria that are applicable to Proposed Project chemicals and toxicity to non-target aquatic wildlife are addressed in Section 14, Human and Ecological Health. Water quality specifications will require that:

- Rotenone and other materials are completely degraded prior to restocking fish and resumption of public contact with the lake waters;
- Toxic concentrations of rotenone do not impact Big Grizzly Creek downstream of Grizzly Valley Dam; and
- Any water quality impairment caused by the rotenone treatment is mitigated so that drinking water quality is not adversely impacted and allows for the survival of restocked fish.

3.2.2.2 Evaluation Methods and Assumptions

Impact Assessment Methodology

This assessment evaluates and identifies water quality impacts that may be short-term (temporary) or long-term. Short-term impacts occur during implementation of the project and for a short period following (up to three months). Long-term impacts last longer than three months and could potentially extend for several years.

Analysis of potential water quality impacts was based on a review of the potential impacts of the chemical applications, Lake Davis water level drawdown, and Big Grizzly Creek flow reductions. Potential impacts that would occur during project implementation and post-project were evaluated. Water quality impact mechanisms associated with physical, chemical and biological effects of the project were identified, including stream channel erosion, reduced lake volume, chemical and biological oxygen consumption, degradation of dead fish, and warming of water temperature. The types of potential impacts include elevated turbidity, reduced dissolved oxygen, increased chemical oxygen demand and biological oxygen demand, increased water temperature, elevated bacteria levels, and increased nutrients in tributary runoff. These impacts could impact aquatic organisms and/or violate water quality standards. Impacts to drinking water quality and potential human health concerns are addressed in Section 14.2.4.2, Human Health and Safety.

3.2.2.3 No Project/No Action

The No Project alternative does not change the current existing water quality conditions in Lake Davis, its tributaries, or Big Grizzly Creek below the dam. There are no water quality impacts associated with the No Project alternative.

3.2.2.4 Proposed Project/Proposed Action – 15,000 Acre-Feet (Plus Treatment)

Elevated Turbidity

Tributaries to Lake Davis may cause sediment erosion in response to the reservoir level drawdown. The sediment erosion would occur due to incision of newly exposed reservoir bottom sediments and possibly from head-cutting of the streams. Tributary flows would carry fine-grained (clay and silt size) sediments and organic deposits to the reservoir, which would remain in suspension for an unknown period of time, thus could cause elevated turbidity levels. This higher turbidity water could also be discharged into Big Grizzly Creek, causing turbidity increases downstream. These impacts could occur whenever the reservoir level is below 45,000 acre-feet and tributary runoff is of sufficient magnitude to entrain sediments, typically March through May (see Section 3.1.2.2 , Evaluation Methods and Assumptions). It is possible that thermal stratification could reduce or slow the settling of suspended materials into the hypolimnion and because water released into Big Grizzly Creek comes from the bottom of the dam, turbidity levels in the creek would not be impacted under those conditions.

Impact WQ-1: Elevated turbidity resulting from erosion caused by head-cutting of tributaries and incision of reservoir sediments and organic deposits is a significant and unavoidable adverse impact.

Anoxic Condition

After the reservoir becomes thermally stratified (late spring to early summer), dissolved oxygen in the hypolimnion is depleted and typically becomes anoxic during the summer. Lowering the reservoir water level would decrease the volume of the hypolimnion by more than 50 percent and the initial available supply of dissolved oxygen. Anoxic conditions in the hypolimnion would develop earlier (possibly several weeks) under this reduced reservoir volume. This impact would occur whenever the reservoir volume is significantly less than the normal operating volume of 45,000 acre-feet, but still deep enough to undergo thermal stratification. At 15,000 acre-feet the water depth in the reservoir is reduced by about 15 feet and the surface area would be about half the area that is present during normal operating volume. Much of the remaining surface area would be less than 20 feet deep. The deeper portions of the reservoir pool (about 25 feet or greater) would still develop thermal stratification and eventually become anoxic at depth.

Two factors could potentially cause thermal stratification to be less stable under this scenario. First, a lower water volume could make the reservoir more susceptible to wind mixing, which could reduce or completely degrade the thermocline and allow mixing throughout the water column. It is possible that the reservoir could experience periods of mixing followed by periods of stratification, depending on weather conditions. Second, the majority of the drawdown would occur from the lowest release point in the dam. Release from this elevation would discharge water from the hypolimnion and may reduce the volume substantially or completely. This could also allow mixing throughout the water column, producing non-stratified reservoir conditions.

Impact WQ-2: Anoxic reservoir condition develops earlier in the summer season than under No Project. The adverse impact is significant and unavoidable.

Reduced Dissolved Oxygen Caused by Biological Oxygen Demand

During the natural rotenone degradation process, oxidation will cause much lower dissolved oxygen concentrations in the lake. This can last up to about three weeks, depending on water temperatures. Because the purpose of this project is to eliminate pike from the reservoir, this lack of dissolved oxygen would not impact fish populations in the long term. This impact would occur for about three weeks following the rotenone treatment.

Following the rotenone treatment, dead fish would be removed from the reservoir, as described in Section 2.3.6, Fish Removal and Disposal. It is possible that not all of the dead fish would be retrieved from the reservoir, and the decomposition of remaining fish carcasses and other aquatic organisms would create a biological oxygen demand. The magnitude of biochemical oxygen demand and reduction in dissolved oxygen concentration is not known and may be localized in shallow near-shore areas. It is assumed that the majority of fish would be removed, and biochemical oxygen demand levels would not significantly reduce overall dissolved oxygen levels in the reservoir. This impact would occur for a period of up to about three months following the treatment.

Impact WQ-3: Reduced dissolved oxygen concentrations throughout the water column caused by biological oxygen demand as a result of the rotenone degradation process and the decomposition of dead fish is a temporary adverse impact that is less than significant.

Mitigation WQ-3: None is required.

Elevated Bacterial Levels

Following the rotenone treatment, the decomposition of dead fish could result in elevated bacteria levels in the water, particularly in near-shore areas. Bacterial levels probably vary from year to year, and may be associated with ongoing contributions from animal wastes, such as wildfowl. Baseline bacteria levels would need to be taken prior to the treatment to determine if levels become elevated from the dead fish. It is assumed that the majority of dead fish would be removed, but there could be locales where they sink, resulting in isolated areas of elevated bacterial levels. This impact would occur for a period of up to about three months following the treatment. Any potential issues associated with human and ecological health concerns are further addressed in Section 14, Human and Ecological Health Concerns.

Impact WQ-4: Elevated bacterial levels associated with the decomposition of dead fish are temporary and, therefore, less than significant adverse impacts.

Mitigation WQ-4: None is required.

Big Grizzly Creek

In order to meet RWQCB waste discharge requirements in Big Grizzly Creek, it is necessary to neutralize rotenone in waters discharged to Big Grizzly Creek (Options 1, 2, and 3) or prevent rotenone-treated waters from entering Big Grizzly Creek. Under the Options 1 and 2, flows from Lake Davis into Big Grizzly Creek would be reduced. Neutralization Option 1 would prevent all flow from discharging into Big Grizzly Creek until rotenone has completely degraded in the reservoir, a period up to three weeks. During this period, water quality conditions in Big Grizzly Creek would degrade as a result of increased water temperatures and reduced dissolved oxygen concentrations that would be detrimental to aquatic organisms in the creek.

Under Neutralization Option 2, a reduced flow of 0.2 cfs would be discharged to Big Grizzly Creek following rotenone neutralization and carbon filtration of this minimal flow from Lake Davis. This reduced flow could last up to three weeks. During this period water quality impacts would be similar as described for the Proposed Method, but may not degrade to the same magnitude or extent since there would be a minimal flow in the creek.

Under Neutralization Option 3, discharge to Lake Davis would be shut off for one to three days followed by a 1 to 2 cfs flow that would be treated to neutralize rotenone. This option could result in some water quality degradation but not of the same magnitude or extent as Options 1 or 2. The effect of reduced dissolved oxygen concentration would likely be restricted to pools within a short distance below the dam (approximately 200 feet below the DWR weir). A reduced but continual flow release would allow for some water oxygenation as it flows through riffle areas. It is expected that reduced flows and water volume would result in some water temperature increase.

Impact WQ-5: Reduced flows in Big Grizzly Creek during the treatment period (under Neutralization Options 1, 2, and 3) could result in decreased dissolved oxygen concentrations and increased water temperatures in Big Grizzly Creek. This adverse impact is significant and unavoidable.

Elevated Turbidity, Nutrients, or Water Temperatures

This concern is specific to Alternative E and does not apply to the Proposed Project.

3.2.2.5 Alternative A – 15,000 Acre-Feet (Plus Treatment Including Powder)

Elevated Turbidity

The drawdown and refill scenario for Alternative A is the same as would be used for the Proposed Project. Water quality impacts related to tributary incision and elevated turbidity are be the same as described in Section 3.2.2.4, Proposed Project.

Impact WQ-6: Elevated turbidity resulting from erosion caused by head-cutting of tributaries and incision of lake sediments and organic deposits is a significant and unavoidable adverse impact.

Anoxic Condition

Under Alternative A, water quality impacts related to development of anoxic reservoir conditions are the same as described for the Proposed Project in Section 3.2.2.4.

Impact WQ-7: Anoxic reservoir condition develops earlier in the summer season than under No Project. The adverse impact is significant and unavoidable.

Reduced Dissolved Oxygen Caused by Bacterial Oxygen Demands

Under Alternative A, water quality impacts related to biological oxygen demand and reduced dissolved oxygen concentrations are the same as described for the Proposed Project in Section 3.2.2.4.

Impact WQ-8: Reduced dissolved oxygen concentrations throughout the water column caused by biological oxygen demand as a result of rotenone degradation and the decomposition of dead fish is a temporary adverse impact that is less than significant.

Mitigation WQ-8: None is required.

Elevated Bacterial Levels

Under Alternative A, water quality impacts related to elevated bacteria levels are the same as described for the Proposed Project in Section 3.2.2.4.

Impact WQ-9: Elevated bacterial levels associated with the decomposition of dead fish are temporary and, therefore, less than significant adverse impacts.

Mitigation WQ-9: None is required.

Big Grizzly Creek

Under Alternative A, water quality impacts related to the Neutralization Options 1, 2, and 3 are the same as described for the Proposed Project in Section 3.2.2.4.

Impact WQ-10: Reduced flows in Big Grizzly Creek during the treatment period (under Neutralization Options 1, 2, and 3) could result in decreased dissolved oxygen concentrations and increased water temperatures in Big Grizzly Creek. This adverse impact is significant and unavoidable.

Elevated Turbidity, Nutrients or Water Temperatures

Issue WQ-11: This issue is specific to Alternative E and does not apply to Alternative A.

3.2.2.6 Alternative B - 5,000 Acre-Feet (Plus Treatment)

Elevated Turbidity

Under Alternative B, the reservoir pool is reduced to a volume of 5,000 acre-feet and a surface area of approximately 545 acres, which is about one-fifth of the surface area under normal operating conditions. The process of tributary incision and resulting elevated turbidity would be similar to that described for the Proposed Project in Section 3.2.2.4. With a smaller pool volume and the potential for deeper channel incision, the resulting turbidity level could be greater than would occur under the Proposed Project. Under Alternative B, the probability that it will take a longer period of time (several years) for the reservoir to refill is greater than for the Proposed Project. This increases the length of time in which the reservoir may experience channel incision and elevated turbidity levels. The magnitude of turbidity impacts under this alternative are expected to be greater than would occur under the Proposed Project or Alternative A.

Impact WQ-12: Elevated turbidity resulting from erosion caused by head-cutting of tributaries and incision of reservoir sediments is a significant and unavoidable adverse impact.

Anoxic Condition

Under Alternative B, the volume of the hypolimnion that develops during summer stratification would be reduced by more than 70 percent. The volume would also be much less than would occur under the Proposed Project. It is likely that little or no stratification would occur under this scenario. With a reduced reservoir volume, the reservoir would be susceptible to wind mixing. The removal of water from the bottom of the reservoir would also significantly reduce the cooler waters that would otherwise be present. Under this scenario anoxic bottom conditions due to thermal stratification would not be expected to occur during the implementation phase but would be expected during subsequent seasons before the refill level has been reached.

Impact WQ-13: Anoxic reservoir condition develops earlier in the summer season than under No Project. The adverse impact is significant and unavoidable.

Reduced Dissolved Oxygen Caused by Chemical Oxygen Demands

Under Alternative B, water quality impacts related to chemical oxygen demand and lower dissolved oxygen levels would be the same as described for the Proposed Project, but would occur in a smaller pool volume.

Reduced Dissolved Oxygen Caused by Biological Oxygen Demands

Under Alternative B, water quality impacts related to decomposition of rotenone and dead fish, BOD and reduced dissolved oxygen levels would be similar to that described for the Proposed Project. While the concentration of dead fish per acre would be greater, it is also expected that it would be easier to collect the majority of fish because the shoreline perimeter would be shorter and more exposed. Therefore, it is assumed that the potential reduction in dissolved oxygen levels would be similar to the Proposed Project.

Impact WQ-14: Reduced dissolved oxygen concentrations throughout the water column caused by biological oxygen demand as a result of the decomposition of rotenone and dead fish is a temporary adverse impact that is less than significant.

Mitigation WQ-14: None is required.

Elevated Bacterial Levels

Following the rotenone treatment, the decomposition of dead fish would result in elevated bacteria levels in the water above background levels, particularly in near-shore areas. It is assumed that the majority of dead fish would be removed, and there would be few areas of elevated bacterial levels. This impact would occur for a period of up to about 3 months following the treatment.

Impact WQ-15: Elevated bacterial levels associated with the decomposition of dead fish are temporary and, therefore, less than significant adverse impacts.

Mitigation WQ-15: None is required.

Big Grizzly Creek

Under Alternative B, water quality impacts related to reduced flows in Big Grizzly Creek would be the same as described for the Proposed Project in Section 3.2.2.4.

Impact WQ-16: Reduced flows in Big Grizzly Creek during the treatment period (under Neutralization Options 1, 2, and 3) could result in decreased dissolved oxygen concentrations and increased water temperatures in Big Grizzly Creek. This adverse impact is significant and unavoidable.

Elevated Turbidity, Nutrients or Water Temperatures

This concern is specific to Alternative E and does not apply to Alternative B.

3.2.2.7 Alternative C – 35,000 Acre-feet (Plus Treatment)

Elevated Turbidity

Under Alternative C, the reservoir pool would be reduced to a volume of 35,000 acre-feet and a surface area of approximately 2,439 acres. The process of tributary incision and resulting elevated turbidity would be similar to that described for the Proposed Project in Section 3.2.2.4. With a larger pool volume and the potential for less channel incision, the resulting turbidity level could be less than would occur under the Proposed Project. Under Alternative C, the probability that it would take a shorter period of time for the reservoir to refill is greater than for the Proposed Project. This may decrease the length of time in which the reservoir would experience channel incision and elevated turbidity levels. The magnitude of turbidity impacts under Alternative C are expected to be less than would occur under the Proposed Project or Alternative B, but still significant.

Impact WQ-17: Elevated turbidity resulting from erosion caused by head-cutting of tributaries and incision of reservoir sediments is a significant and unavoidable adverse impact.

Anoxic Condition

Under Alternative C, the volume of the hypolimnion that would develop during summer stratification would be reduced by about 30 percent. The volume would be larger than would occur under the Proposed Project. The water quality impact would be similar to that described for the Proposed Project in Section 3.2.2.4. Since information is not available to calculate the hypolimnion volumes, this analysis assumes that anoxic conditions would develop later in the summer under Alternative C than under the Proposed Project, but earlier than under normal operating conditions.

Impact WQ-18: Anoxic reservoir condition develops earlier in the summer season than under No Project. This adverse impact is significant and unavoidable.

Reduced Dissolved Oxygen Caused by Biological Oxygen Demands

Under Alternative C, water quality impacts related to decomposition of rotenone and dead fish, BOD and reduced dissolved oxygen levels would be similar to those described for the Proposed Project. While the concentration of dead fish per acre would be smaller, it is also expected that it would be more difficult to collect the majority of fish because the shoreline perimeter would be longer. Therefore, it is assumed that the potential reduction in dissolved oxygen levels would be similar to the Proposed Project.

Impact WQ-19: Reduced dissolved oxygen concentrations throughout the water column caused by biological oxygen demand as a result of the decomposition of rotenone and dead fish is a temporary adverse impact that is less than significant.

Mitigation WQ-19: None is required.

Elevated Bacterial Levels

Following the rotenone treatment, the decomposition of dead fish would result in elevated bacteria levels in the water, particularly in near-shore areas. It is assumed that the majority of dead fish would be removed and there would be few areas of elevated bacterial levels. This impact would occur for a period of up to about three months following the treatment.

Impact WQ-20: Elevated bacterial levels associated with the decomposition of dead fish are temporary and, therefore, less than significant adverse impacts.

Mitigation WQ-20: None is required.

Big Grizzly Creek

Under Alternative C, water quality impacts related to reduced flows in Big Grizzly Creek would be the same as described for the Proposed Project in Section 3.2.2.4.

Impact WQ-21: Reduced flows in Big Grizzly Creek during the treatment period (under Neutralization Options 1, 2, and 3) could result in decreased dissolved oxygen concentrations and increased water temperatures in Big Grizzly Creek. This adverse impact is significant and unavoidable.

Elevated Turbidity, Nutrients or Water Temperatures

This concern is specific to Alternative E and does not apply to Alternative C.

3.2.2.8 Alternative D – 48,000 Acre-Feet (Plus Treatment)

Elevated Turbidity

Under Alternative D, the reservoir pool would be managed to a volume of 48,000 acre-feet and a surface area of approximately 2,936 acres. The process of tributary incision and head-cutting is not expected to be significant at this water level. Therefore, significant elevated turbidity levels are not expected to occur.

Impact WQ-22: Elevated turbidity resulting from erosion caused by head-cutting of tributaries and incision of reservoir sediments is a less than significant adverse impact.

Mitigation WQ-22: None is required.

Anoxic Condition

Under Alternative D, the volume of the hypolimnion that would develop during summer stratification would not be reduced relative to average operating conditions. There would be no impact on the time when an anoxic lake condition would develop.

Impact WQ-23: Anoxic reservoir condition develops earlier in the summer season than under No Project. There is no adverse impact.

Mitigation WQ-23: None is required.

Reduced Dissolved Oxygen Caused by Biological Oxygen Demands

Under Alternative D, water quality impacts related to decomposition of rotenone and dead fish, BOD and reduced dissolved oxygen levels would be similar to that described for the Proposed Project. While the concentration of dead fish per acre would be smaller, it is also expected that it would be more difficult to collect the majority of fish because the shoreline perimeter would be longer and more difficult to access. Therefore, it is assumed that the potential reduction in dissolved oxygen levels would be similar to the Proposed Project.

Impact WQ-24: Reduced dissolved oxygen concentrations throughout the water column caused by biological oxygen demand as a result of the decomposition of rotenone and dead fish is a temporary adverse impact that is less than significant.

Mitigation WQ-24: None is required.

Elevated Bacterial Levels

Following the rotenone treatment, the decomposition of dead fish would result in elevated bacteria levels in the water, particularly in near-shore areas. It is assumed that the majority of dead fish would be removed and there would be few areas of elevated bacterial levels. This impact would occur for a period of up to about three months following the treatment.

Impact WQ-25: Elevated bacterial levels associated with the decomposition of dead fish are temporary and, therefore, less than significant adverse impacts.

Mitigation WQ-25: None is required.

Big Grizzly Creek

Under Alternative D, water quality impacts related to reduced flows in Big Grizzly Creek would be the same as described for the Proposed Project in Section 3.2.2.4.

Impact WQ-26: Reduced flows in Big Grizzly Creek during the treatment period (under Neutralization Options 1, 2, and 3) could result in decreased dissolved oxygen

concentrations and increased water temperatures in Big Grizzly Creek. This adverse impact is significant and unavoidable.

Elevated Turbidity, Nutrients or Water Temperatures

This concern is specific to Alternative E and does not apply to Alternative D.

3.2.2.9 Alternative E – Dewater Reservoir and Tributaries (No Chemical Treatment)

Elevated Turbidity

Under Alternative E, the reservoir pool would be reduced to a volume of zero acre-feet and a surface area of zero acre. The process of tributary incision would be similar to that described for the Proposed Project in Section 3.2.2.4. During the project implementation phase, elevated turbidity would not be an issue because there would be no reservoir pool and it is assumed that any tributary flows would become subsurface in the reservoir or diminish before reaching the lowest point in the reservoir. However, it would take from one to four years to refill the reservoir. During the refill period the reservoir pool would be susceptible to elevated turbidity caused by incised tributaries delivering suspended sediment to the reservoir. Under Alternative E, the probability that it would take a longer period of time (several years) for the reservoir to refill is greater than for the Proposed Project or Alternatives A through D. This would increase the length of time in which the reservoir may experience channel incision and elevated turbidity levels. The potential magnitude and extent of turbidity impacts under Alternative E are expected to be greater than would occur under the Proposed Project or any other alternative.

Impact WQ-27: Elevated turbidity resulting from erosion caused by head-cutting of tributaries and incision of reservoir sediments is a significant and unavoidable adverse impact.

Anoxic Condition

Under Alternative E, an anoxic lake condition would not be a concern during project implementation because a reservoir pool would not exist. However, during subsequent years until the pool has refilled, a reduced reservoir volume would result in a reduced hypolimnion volume with anoxic conditions occurring earlier in the summer. The water quality impact would be similar to that described for the Proposed Project in Section 3.2.2.4. Since information is not available to calculate the hypolimnion volumes, this analysis will assume that anoxic conditions and the water quality impact would be similar to Alternative B, which is a minimal pool. Water quality impacts would be greater than the Proposed Project and Alternatives A, C and D.

Impact WQ-28: Anoxic reservoir condition develops earlier in the summer season than under No Impact. This adverse impact is significant and unavoidable.

Reduced Dissolved Oxygen Caused by Biological Oxygen Demands

This impact concern does not apply to Alternative E because rotenone would not be applied and there would not be a reservoir pool present.

Impact WQ-29: Reduced dissolved oxygen concentrations throughout the water column caused by biological oxygen demand as a result of the decomposition of dead fish. There is no adverse impact.

Elevated Bacterial Levels

This impact concern does not apply to Alternative E because dead fish would not be present in the reservoir pool when it begins to refill.

Impact WQ-30: Elevated bacterial levels associated with the decomposition of dead fish. There is no adverse impact.

Big Grizzly Creek

Under Alternative E, neutralization would not be required because rotenone would not be applied. However, reduced flow to Big Grizzly Creek would be a concern during the project implementation phase and until the reservoir refills to a level high enough to discharge downstream through the outlet in the dam. Depending on the length of time that downstream flow would be reduced or non-existent, the magnitude of water quality impacts in Big Grizzly Creek could be greater under Alternative E than under the Proposed Project or any other alternative. During the reduced flow period, water quality conditions in Big Grizzly Creek would degrade as a result of increased water temperatures and reduced dissolved oxygen concentrations, which would be detrimental to aquatic organisms in the creek. It is possible that flow in Big Grizzly Creek or a portion of the creek would stop for a period of time.

Impact WQ-31: Reduced flows in Big Grizzly Creek during the dewatered period could result in decreased dissolved oxygen concentrations and increased water temperatures in Big Grizzly Creek. This adverse impact is significant and unavoidable.

Elevated Turbidity, Nutrients or Water Temperatures

Under Alternative E, the tributary stream channels would be disturbed approximately every several hundred to 1,000 feet by the construction of the cofferdams necessary to dewater the channel. These cofferdams would be constructed of sandbags covered with plastic sheeting. Construction would likely cause some disturbance of the stream bottom for a width of 10 to 15 feet extending across the channel at each location. Access along the length of the stream would be provided by existing roads. Unless a pre-existing path can be used, a path to access the stream at each location would need to be constructed, requiring pruning or removal of a narrow corridor within the riparian zone. It would also be necessary to remove a minor amount of vegetation where the cofferdam contacts each bank. Cofferdam construction is likely to result in a minor amount of increased sedimentation from the disturbance of the streambed. Sandbags would not be emptied into the stream, so should not result in a substantial increase in sedimentation or turbidity. Riparian vegetation would recover to its pre-project state by the following summer. There may be additional areas of exposed streambank during the following spring, which may contribute to additional erosion during the runoff period, but the overall area of exposure would be relatively small. The small amount of vegetation to be removed would not be expected to substantially warm stream temperatures. The amount of sediment contributed by the cofferdam construction and associated pruning of riparian vegetation would be insignificant. While these activities could elevate turbidity and increase nutrients inflow to Lake Davis, these adverse impacts would be less than significant.

Impact WQ-32: Elevated turbidity, nutrients and water temperatures resulting from cofferdam construction and associated vegetation removal are anticipated to be less than significant adverse impacts.

Mitigation WQ-32: No mitigation is required.

3.2.2.10 Cumulative Impacts

Previous, present or future projects and actions that were considered in this cumulative impact analysis for surface water quality resources include the following:

- USFS grazing allotments;
- Timber harvest – this includes numerous timber and salvage sales;
- USFS forest management projects (fuels reduction including timber harvest, thinning and group selection);
- Grizzly Ranch Development Project;
- USFS watershed restoration projects; and
- USFS Westside Lake Davis Restoration Project.

The cumulative impacts analysis area includes the watershed area of Lake Davis and its tributary streams and Big Grizzly Creek from below the dam to its confluence with the Middle Fork Feather River. The time frame for this analysis begins when drawdown of Lake Davis is initiated and extends until the lake has refilled to the 45,000 acre-feet level. The time to refill would vary from zero to 80 months depending on the alternative and climatic conditions following drawdown and treatment. For the purpose of this analysis, the Proposed Project and Alternatives A, B, C, and E are assumed to take 80 months (6.7 years). In Alternative D the time to refill would be zero month because there would no drawdown.

This analysis describes the potential cumulative impacts of the Proposed Project and Alternatives A through E on surface water quality when considered in combination with other past, present, and reasonably foreseeable actions and baseline conditions.

Effects of Other Projects

A brief description of the time period and likely effects of other projects considered in this analysis is provided below.

USFS Grazing Allotments

Livestock grazing has been ongoing in the analysis area from the mid-1880s until the present. Intensive sheep and cattle grazing occurred through about the 1920s, when the Plumas National Forest began to manage cattle grazing allotments. Meadows and streams were degraded, including substantial erosion of surface soils. With fewer cattle permitted, and implementation of watershed restoration projects since the 1980s, there has been a slow recovery in the watershed. However, it is assumed that the impacts of continued cattle grazing are substantial and includes both surface soil erosion and nutrient inputs in the streams and Lake Davis.

Timber Harvest Projects

As with cattle grazing, the impacts of timber harvesting in the analysis area date back to the early 1900s and continue to the present. Timber harvesting impacts soils through road, skid and landing construction; displacement of topsoil; and loss of soil due to surface erosion. The impacts include increased sediment delivery to tributaries and Lake Davis.

USFS Forest and Fuels Management Projects

In addition to timber harvest projects, the USFS conducts forest and fuels management activities in the analysis area. This includes reduction in fire hazard through tree removal to reduce fire hazard, thinning for forest health, salvage cutting, pole cutting, tree planting, and public fuel wood-cutting. These types of activities have occurred from about 1980 to the present. The impacts are assumed to be much less substantial than timber harvest activities and some would have beneficial impacts after a period of time.

Grizzly Ranch Development Project

The Grizzly Ranch Development Project is a residential subdivision that includes 380 homes on 1,042 acres, including a golf course. The project is currently underway and will be completed in the near future. During the construction period, project effects could include soil erosion and delivery to Big Grizzly Creek, thus increasing sediment and nutrients delivered to the stream. Treated wastewater from the Grizzly Ranch Development Project is delivered to Middle Fork Feather River, not to Big Grizzly Creek. Therefore there are no cumulative impacts to water quality associated with wastewater from the Grizzly Ranch Development Project on Big Grizzly Creek.

USFS Watershed Restoration Projects

The USFS performed a variety of restoration projects in Freeman Creek and Cow Creek from 1980 to 2000. Restoration activities included livestock enclosures, bank stabilization, willow planting, road closures and reseeding of disturbed areas. These projects are assumed to have reduced soil erosion and discharge problems in these areas, thus reducing sedimentation and suspended sediment in the tributaries and Lake Davis. Although these actions are assumed to have reduced the problems, erosion and sedimentation still occur.

USFS Westside Lake Davis Restoration Project

The USFS is presently conducting restoration activities on 50 head-cuts and gullies to improve channel stability and reduce sedimentation in 20 streams on the west side of Lake Davis. While it is assumed that this will improve sediment problems in the tributaries and Lake Davis during the timeframe of the Lake Davis Pike Eradication Project, erosion and sedimentation problems will still exist.

Proposed Project and Alternative A

Potential surface water quality impacts from the Proposed Project and Alternative A include elevated turbidity in Lake Davis, a longer period of anoxia in the lower water column, and reduced dissolved oxygen concentrations in Lake Davis, elevated bacterial levels, and reduced dissolved oxygen, increased water temperatures, and elevated turbidity in Big Grizzly Creek. The period of anoxic condition in the reservoir bottom is not influenced by the other projects under consideration and therefore does not involve a cumulative impact. Similarly, reduced dissolved oxygen levels in Lake Davis would not be influenced by other projects and therefore does not constitute a cumulative impact. Cumulative impacts that are considered substantial in combination with other projects include:

- Turbidity in Lake Davis – combined with cattle grazing and logging effects on soil erosion;
- Elevated bacteria level – combined with elevated bacteria levels associated with cattle grazing; and
- Increased turbidity (suspended sediment) and reduced dissolved oxygen in Big Grizzly Creek – combined with the effects of additional sediment and nutrient inputs from the Grizzly Ranch Development Project.

Alternative B

The types of cumulative impacts for Alternative B are the same as described above for the Proposed Project and Alternative A. Because the magnitude and duration of turbidity impacts caused by Alternative B have the potential to be larger than the Proposed Project and Alternative A, the cumulative turbidity (suspended sediment) effects are potentially greater. Similarly, cumulative turbidity and dissolved oxygen impacts in Big Grizzly Creek below the dam could potentially be greater under Alternative B due to increased turbidity discharges and/or decreased flows to Big Grizzly Creek from Lake Davis. Cumulative bacteria impacts are expected to be the same as described for the Proposed Project/Alternative A.

Alternative C

The types of cumulative impacts for Alternative C are the same as described above for the Proposed Project and Alternative A. Because the magnitude and duration of turbidity effects caused by Alternative C have the potential to be smaller than the Proposed Project and Alternative A, the cumulative turbidity effects are potentially smaller. Similarly, cumulative turbidity impacts in Big Grizzly Creek below the dam could potentially be smaller under Alternative C due to decreased turbidity discharges from Lake Davis. Cumulative dissolved oxygen impacts in Big Grizzly Creek are the same as described for the Proposed Project/Alternative A. Cumulative bacteria impacts are expected to be the same as described for the Proposed Project/Alternative A.

Alternative D

Potential surface water quality impacts from Alternative D include: reduced dissolved oxygen concentrations in Lake Davis, elevated bacterial levels, and reduced dissolved oxygen and increased water temperatures in Big Grizzly Creek. Reduced dissolved oxygen levels in Lake Davis would not be influenced by other projects and therefore does not constitute a cumulative impact. Cumulative bacteria effects are expected to be the same as described for the Proposed Project/Alternative A. Cumulative dissolved oxygen effects in Big Grizzly Creek below the dam would be the same as described for the Proposed Project/Alternative A.

Alternative E

Potential surface water quality impacts from Alternative E include: elevated turbidity in Lake Davis, a longer period of anoxia in the lower water column, reduced dissolved oxygen, increased water temperatures and elevated turbidity in Big Grizzly Creek, and elevated turbidity, nutrients, and water temperature in tributary streams. The period of anoxic condition in the reservoir bottom is not influenced by the other projects under consideration and therefore does not involve a cumulative impact. Cumulative impacts that are considered substantial in combination with other projects include:

- Turbidity in Lake Davis – combined with cattle grazing and logging effects on soil erosion;
- Increased turbidity (suspended sediment) and reduced dissolved oxygen in Big Grizzly Creek – combined with the effects of additional sediment and nutrient inputs from the Grizzly Ranch Development Project; and
- Elevated turbidity, nutrients and water temperature in tributary streams – combined with the effects of cattle grazing, logging and fuels management projects in the same watershed areas.

Conclusion

Cumulative impacts would be expected with the Proposed Project and all five project alternatives. Because there is no drawdown under Alternative D, the potential cumulative impacts of Alternative D are expected to be less than all other alternatives. The cumulative impacts of the Proposed Project and Alternatives A, B, C, and E are similar but would probably be of a different magnitude and duration. Under Alternative E, the potential cumulative impacts of turbidity and nutrient inputs are greatest because the period of refill would potentially be the longest.

3.2.2.11 Environmental Impacts Summary

This section and Table 3.2-1 summarize the environmental impacts discussed in Section 3.2.2 for surface water quality. Under the No Project alternative (same as existing conditions), there would be no impact to surface water quality.

The Proposed Project and all five project alternatives would have water quality impacts associated with their implementation. The Proposed Project and Alternatives A, B, and C have the same types of impacts. However, the magnitude of their impacts would likely differ due to different draw down levels and times to refill following implementation.

The Proposed Project and Alternatives A, B, C, and E would have a significant and unavoidable turbidity impact in Lake Davis and downstream in Big Grizzly Creek. Incision caused by erosion of tributaries and reservoir bed sediments would occur under all four options, but would be greatest under the lowest reservoir levels, Alternatives B and E. It is possible that under these conditions the tributaries would not reach the reservoir pool and turbidity would not be increased during the period that the reservoir is at 5,000 acre-feet or completely drawn down. However, as the reservoir begins to refill in subsequent seasons elevated turbidity would be expected in the reservoir pool. Alternative D does not have an impact on turbidity since the reservoir level remains within normal operating levels.

The Proposed Project and Alternatives A, B, C, and E would have a significant and unavoidable impact on anoxic conditions in the lower water column. Anoxic conditions in the hypolimnion would be expected to occur earlier in the season due to its reduced volume compared to No Project. Under Alternative B, this would not occur during the implementation phase, but would be expected during subsequent seasons before the refill level has been reached. Under Alternative D, no impact to the timing of anoxic conditions would occur.

The Proposed Project and Alternatives A, B, C, and D would have less than significant impacts related to biological oxygen demand, and elevated bacterial levels. These impacts would be directly related to the rotenone treatment and would be temporary, lasting a matter of weeks or a couple of months. These effects do not apply to Alternative E since a rotenone treatment would not be applied.

Under the Proposed Project and Alternatives A, B, C, D, and E, reduced flow in Big Grizzly Creek would result in decreased dissolved oxygen concentrations and increased water temperature. This is considered a significant and unavoidable impact. The magnitude of this effect would depend on which neutralization option is implemented. Option 1 would have the largest effect because flow would not be returned to Big Grizzly Creek until rotenone has completely dissipated in the reservoir (up to three weeks). Option 2 maintains a flow of about 0.2 to 0.5 cfs and Option 3 maintains a flow of about 1 to 2 cfs following a 24- to 72-hour period of no flow. Assuming the neutralization process is effective and there are no problems related to insufficient or excess potassium permanganate, the effects of reduced flows in Big Grizzly Creek would be less under Options 2 and 3 and would not occur under Option 4, which does not involve a reduction in flow.

No impacts related to disturbance in and near tributary streams would occur under the Proposed Project or Alternatives A, B, C, and D. Under Alternative E, disturbance of soils, vegetation, and instream substrates would occur in relation to all flowing tributary streams. These impacts are considered less than significant.

Table 3.2-1. Summary Comparison of Impacts of Alternatives

Affected Resource and Area of Potential Impact	Alternative						
	No Project Compared to Existing Conditions	Proposed Project	A	B	C	D	E
Surface Water Quality							
1. Elevated turbidity due to erosion of lake sediments	N	SU, A	SU, A	SU, A	SU, A	N	SU, A
2. Anoxic reservoir condition develops earlier in summer	N	SU, A	SU, A	SU, A	SU, A	N	SU, A
3. Reduced dissolved oxygen due to biological oxygen demand	N	LS, A	LS, A	LS, A	LS, A	LS, A	na
4. Elevated bacterial levels associated with decomposing fish	N	LS, A	LS, A	LS, A	LS, A	LS, A	na
5. Reduced flow in Big Grizzly Creek results in decreased dissolved oxygen and increased water temperature	N	SU, A	SU, A	SU, A	SU, A	SU, A	SU, A
6. Disturbance in and near tributary streams results in elevated turbidity, nutrients and/or water temperatures	N	N	N	N	N	N	LS, A

Key:
A = Adverse Impact (NEPA)
B = Beneficial Impact (NEPA)
LS = Less than Significant Impact (CEQA)
N = No Impact (CEQA, NEPA)
na = Not applicable
SM = Significant but Mitigable Impact (CEQA)
SU = Significant and Unavoidable Impact (CEQA)

3.2.2.12 Monitoring

Surface water quality in Lake Davis and Big Grizzly Creek will be monitored under a program developed by DFG in consultation with and as required by the California Department of Health Services, the Central Valley Regional Water Quality Control Board and in consultation with Plumas County Environmental Health. Some or all portions of the monitoring program may developed as part of permitting requirements under the National Pollution Discharge Elimination System permitting program (administered by the Central Valley Regional Water Quality Control Board) and/or the California Public Health and Safety Code Section 116571 (administered by the California Department of Health Services).

The surface water quality monitoring program will specify parameters to be monitored, and may include chemical constituents of rotenone formulation, water temperature, hardness, alkalinity, total organic carbon, specific conductivity, ammonia, pH, BOD, dissolved oxygen levels and bioassays using rainbow trout. The program will specify monitoring location, duration, and frequency, including the method for establishing baseline conditions.